# COUNTY OF LOS ANGELES
## DEPARTMENT OF PUBLIC WORKS

*"To Enrich Lives Through Effective and Caring Service"*

900 SOUTH FREMONT AVENUE
ALHAMBRA, CALIFORNIA 91803-1331
Telephone: (626) 458-5100
http://dpw.lacounty.gov

GAIL FARBER, Director

ADDRESS ALL CORRESPONDENCE TO:
P.O. BOX 1460
ALHAMBRA, CALIFORNIA 91802-1460


May 11, 2010

ADOPTED
BOARD OF SUPERVISORS
COUNTY OF LOS ANGELES
#53 MAY 11, 2010
Sachi A. Hamai
SACHI A. HAMAI
EXECUTIVE OFFICER

The Honorable Board of Supervisors
County of Los Angeles
383 Kenneth Hahn Hall of Administration
500 West Temple Street
Los Angeles, California 90012

Dear Supervisors:

**LOS ANGELES COUNTY WATERWORKS DISTRICT NO. 40, ANTELOPE VALLEY, APPROVAL OF NEGATIVE DECLARATION, AUTHORIZATION TO PROCEED, AND AUTHORIZATION TO SIGN TWO SEPARATE JOINT FUNDING AGREEMENTS WITH THE UNITED STATES GEOLOGICAL SURVEY AND THE WATER RESEARCH FOUNDATION TO CARRY OUT AN IN-SITU ARSENIC REMOVAL PROJECT (SUPERVISORIAL DISTRICT 5) (3 VOTES)**

**SUBJECT**

This action is to authorize the Department of Public Works to carry out the Los Angeles County Waterworks District No. 40, Antelope Valley, In-Situ Arsenic Removal project; approve the project's Negative Declaration; and authorize the Director of Public Works or her designee to sign two separate joint funding agreements with the United States Geological Survey and the Water Research Foundation to complete the project at a not to exceed cost of $438,000 for the Los Angeles County Waterworks District No. 40, Antelope Valley.

**IT IS RECOMMENDED THAT YOUR BOARD ACTING AS THE GOVERNING BODY OF THE LOS ANGELES COUNTY WATERWORKS DISTRICT NO. 40, ANTELOPE VALLEY:**

1. Consider and approve the Negative Declaration for the In-Situ Arsenic Removal project in the Willow Springs area of Antelope Valley; determine that the project will not have a significant impact on the environment; and find that the Negative Declaration reflects the independent judgment of the County.

2. Approve the In-Situ Arsenic Removal project and authorize the Department of Public Works to carry out the project.

3. Authorize the Director of Public Works or her designee to sign two separate joint funding agreements with the United States Geological Survey and the Water Research Foundation to conduct the In-Situ Arsenic Removal project at a not-to-exceed cost of $438,000 for the Los Angeles County Waterworks District No. 40, Antelope Valley.

## PURPOSE/JUSTIFICATION OF RECOMMENDED ACTION

The purpose of the recommended actions is to allow the Department of Public Works to evaluate the effectiveness and sustainability of naturally occurring minerals (alumina, iron, and manganese oxides) in soil to remove arsenic from water that contains arsenic level above drinking water standards and to authorize the Director of Public Works or her designee to sign two separate joint funding agreements with the United States Geological Survey (Enclosure A) and the Water Research Foundation (Enclosure B) to conduct the Los Angeles County Waterworks District No. 40, Antelope Valley (District), In-Situ Arsenic Removal project. If proven successful, it will allow the District to implement this cost-effective arsenic removal strategy in other areas of the Antelope Valley where the District operates wells with water that contain arsenic levels above drinking water standards.

### Implementation of Strategic Plan Goals

The Countywide Strategic Plan directs the provision of Operational Effectiveness (Goal 1) by actively seeking external funding sources and Community and Municipal Services (Goal 3) by providing responsive and responsible potable water services, thereby, improving the quality of life of the Los Angeles County residents. This project will leverage findings and expertise of staff from outside agencies to investigate a potentially very cost-effective method to treat the District's groundwater with arsenic level above drinking water standards.

## FISCAL IMPACT/FINANCING

There will be no impact to the County General Fund.

The total cost of the project is $998,464. Of that amount, the United States Geological Survey will contribute $135,000, the Water Research Foundation will contribute $150,000, and the District will contribute $438,000. The remaining amount will be in kind services by the Antelope Valley-East Kern Water Agency, the wholesale water supplier for the District, in the amount of $180,000 and the District in the amount of $95,464. Sufficient funds are available for the District's share of the cost in the District's Fiscal Year 2010-11 Proposed General Fund Budget (N63).

## FACTS AND PROVISIONS/LEGAL REQUIREMENTS

Under the California Environmental Quality Act (CEQA), any lead agency preparing a Negative Declaration must provide a public notice within a reasonable period of time prior to certification of the Negative Declaration. To comply with this requirement, a Public Notice, pursuant to Section 21092 of the Public Resources Code, was published in the Antelope Valley Press and the Los Angeles Daily Times on February 17, 2010. A copy of the Negative Declaration (Enclosure C) was provided to the Lancaster Library for public review. In addition, 15 copies of the Negative Declaration were sent to the State Clearing House, who distributed the document to the necessary agencies.

During the public review period, we received a comment from the Lahontan Regional Water Quality Control Board (LRWQCB). A response letter was sent to LRWQCB on April 1, 2010. This letter is included in the Negative Declaration.

The joint funding agreements have been reviewed and approved as to form by County Counsel.

**ENVIRONMENTAL DOCUMENTATION**

CEQA requires public agency decision makers to document and consider environmental implications of their actions.

The Negative Declaration was written pursuant to the CEQA Guidelines of 1970, as amended (Division 13, California Public Resources Code), and the CEQA Guidelines (Division 6, California Administrative Code).

Upon approval of the Negative Declaration by your Board, we will file a Notice of Determination in accordance with the requirements of Section 21152(a) of the California Public Resources Code.

**IMPACT ON CURRENT SERVICES (OR PROJECTS)**

There will be no negative impact on current County services or projects during the performance of the recommended services.

**CONCLUSION**

Please return three adopted copies of this letter to the Department of Public Works, Waterworks Division.

Respectfully submitted,

Gail Farber

GAIL FARBER
Director

GF:AA:lr

c: Chief Executive Office (Lari Sheehan)
County Counsel
Executive Office

# ENCLOSURE A



Form 9-1366
(Oct. 2005)

## U.S. Department of the Interior
## U.S. Geological Survey
## Joint Funding Agreement

| | |
|---|---|
| Customer #: | CA055 |
| Agreement #: | 10W4CAD05500 |
| Project #: | |
| TIN #: | 95-6000927 |
| Fixed Cost Agreement | ☑ Yes ☐ No |

**FOR**
**WATER RESOURCES INVESTIGATIONS**

THIS AGREEMENT is entered into as of the 24 day of March, 2010, by the U.S. GEOLOGICAL SURVEY, UNITED STATES DEPARTMENT OF THE INTERIOR, party of the first part, and the LOS ANGELES COUNTY DEPARTMENT OF PUBLIC WORKS, party of the second part.

1 The parties hereto agree that subject to availability of appropriations and in accordance with their respective authorities there shall be maintained in cooperation between the LACDPW and USGS to investigate insitue arsenic removal on unsaturated alluvium in the Antelope Valley, herein called the program. The USGS legal authority is 43 USC 36C; 43 USC 50; and 43 USC 50b.

2 The following amounts shall be contributed to cover all of the cost of the necessary field and analytical work directly related to this program. 2(b) includes In-Kind Services in the amount of $0

by the party of the first part during the period

(a) $50,000.00 May 1, 2010 **to** December 31, 2013

by the party of the second part during the period

(b) $58,000.00 May 1. 2010 **to** December 31, 2013

USGS DUNS IS 1761-38857.

(c) Additional or reduced amounts by each party during the above period or succeeding periods as may be determined by mutual agreement and set forth in an exchange of letters between the parties.

(d) The performance period may be changed by mutual agreement and set forth in an exchange of letters between the parties.

3. The costs of this program may be paid by either party in conformity with the laws and regulations respectively governing each party
4 The field and analytical work pertaining to this program shall be under the direction of or subject to periodic review by an authorized representative of the party of the first part.
5. The areas to be included in the program shall be determined by mutual agreement between the parties hereto or their authorized representatives. The methods employed in the field and office shall be those adopted by the party of the first part to insure the required standards of accuracy subject to modification by mutual agreement.
6 During the course of this program, all field and analytical work of either party pertaining to this program shall be open to the inspection of the other party, and if the work is not being carried on in a mutually satisfactory manner, either party may terminate this agreement upon 60 days written notice to the other party
7. The original records resulting from this program will be deposited in the office of origin of those records. Upon request, copies of the original records will be provided to the office of the other party

Page 2 of 2

| Form 9-1366 continued | U.S. Department of the Interior U.S. Geological Survey Joint Funding Agreement | Customer #: | CA055 |
|---|---|---|---|
| | | Agreement #: | 10W4CAD05500 |
| | | Project #. | |
| | | TIN #: | 95-6000927 |

8 The maps, records, or reports resulting from this program shall be made available to the public as promptly as possible. The maps, records, or reports normally will be published by the party of the first part. However. the party of the second part reserves the right to publish the results of this program and, if already published by the party of the first part shall, upon request, be furnished by the party of the first part, at costs, impressions suitable for purposes of reproduction similar to that for which the original copy was prepared. The maps, records, or reports published by either party shall contain a statement of the cooperative relations between the parties.

9. USGS will issue billings utilizing Department of the Interior Bill for Collection (form DI-1040) Billing documents are to be rendered **quarterly** Payments of bills are due within 60 days after the billing date. If not paid by the due date, interest will be charged at the current Treasury rate for each 30 day period, or portion thereof. that the payment is delayed beyond the due date. (31 USC 3717; Comptroller General File B-212222, August 23, 1983).

**U.S. Geological Survey**
**United States**
**Department of the Interior**

**USGS Point of Contact**

Name: Irene A. Rios
Address: 6000 J Street, Placer Hall
Sacramento, California 95819-6129
Telephone: 619-225-6156
Email: iarios@usgs.gov

**Signatures**

By_____ Date_____
Name: Eric G. Reichard
Title: Director, USGS California Water Science Center

By_____ Date_____
Name:
Title:

By_____ Date_____
Name:
Title:

**LOS ANGELES COUNTY DEPARTMENT OF PUBLIC WORKS**

**Customer Point of Contact**

Name: T.J Kim
Address: 900 South Fremont Avenue
Alhambra, California 91803
Telephone: 626-300-3327
Email: tjkim@dpw.lacounty gov

**Signatures**

By_____ Date_____
Name: Gail Farber
Title: Director

By_____ Date_____
Name:
Title:

By_____ Date_____
Name:
Title:

Page 1 of 2

Form 9-1366
(Oct. 2005)

# U.S. Department of the Interior
# U.S. Geological Survey
# Joint Funding Agreement

| | |
|---|---|
| Customer #: | CA055 |
| Agreement #: | 10W4CAD05510 |
| Project #: | |
| TIN #: | 95-6000927 |
| Fixed Cost Agreement | ☐ Yes ☑ No |

**FOR**
**WATER RESOURCES INVESTIGATIONS**

THIS AGREEMENT is entered into as of the 24 day of March, 2010, by the U.S. GEOLOGICAL SURVEY. UNITED STATES DEPARTMENT OF THE INTERIOR, party of the first part, and the LOS ANGELES COUNTY DEPARTMENT OF PUBLIC WORKS, party of the second part.

1 The parties hereto agree that subject to availability of appropriations and in accordance with their respective authorities there shall be maintained in cooperation between the LACDPW and USGS to investigate (drilling) insitue arsenic removal on unsaturated alluvium in the antelope Valley, herein called the program The USGS legal authority is 43 USC 36C, 43 USC 50; and 43 USC 50b.

2 The following amounts shall be contributed to cover all of the cost of the necessary field and analytical work directly related to this program 2(b) includes In-Kind Services in the amount of $0.

by the party of the first part during the period

(a) $0.00 May 1, 2010 **to** December 31. 2013

by the party of the second part during the period

(b) $180,000 00 May 1, 2010 **to** December 31, 2013

USGS DUNS IS 1761-38857

(c) Additional or reduced amounts by each party during the above period or succeeding periods as may be determined by mutual agreement and set forth in an exchange of letters between the parties.

(d) The performance period may be changed by mutual agreement and set forth in an exchange of letters between the parties.

3. The costs of this program may be paid by either party in conformity with the laws and regulations respectively governing each party
4 The field and analytical work pertaining to this program shall be under the direction of or subject to periodic review by an authorized representative of the party of the first part.
5 The areas to be included in the program shall be determined by mutual agreement between the parties hereto or their authorized representatives. The methods employed in the field and office shall be those adopted by the party of the first part to insure the required standards of accuracy subject to modification by mutual agreement.
6. During the course of this program, all field and analytical work of either party pertaining to this program shall be open to the inspection of the other party, and if the work is not being carried on in a mutually satisfactory manner. either party may terminate this agreement upon 60 days written notice to the other party
7 The original records resulting from this program will be deposited in the office of origin of those records. Upon request, copies of the original records will be provided to the office of the other party.

Page 2 of 2

| Form 9-1366 continued | U.S. Department of the Interior U.S. Geological Survey Joint Funding Agreement | Customer #: | CA055 |
|---|---|---|---|
| | | Agreement #. | 10W4CAD05510 |
| | | Project #: | |
| | | TIN # | 95-6000927 |

8. The maps, records, or reports resulting from this program shall be made available to the public as promptly as possible. The maps, records, or reports normally will be published by the party of the first part. However, the party of the second part reserves the right to publish the results of this program and, if already published by the party of the first part shall, upon request, be furnished by the party of the first part, at costs, impressions suitable for purposes of reproduction similar to that for which the original copy was prepared. The maps, records, or reports published by either party shall contain a statement of the cooperative relations between the parties.
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**U.S. Geological Survey**
**United States**
**Department of the Interior**

**USGS Point of Contact**

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Telephone: 619-225-6156
Email: iarios@usgs.gov

**Signatures**

By_____ Date_____
Name: Eric G. Reichard
Title: Director, USGS California Water Science Center

By_____ Date_____
Name:
Title:

By_____ Date_____
Name:
Title:

**LOS ANGELES COUNTY DEPARTMENT OF PUBLIC WORKS**

**Customer Point of Contact**

Name: T.J Kim
Address: 900 South Fremont Avenue
Alhambra, California 91803
Telephone: 626-300-3327
Email: tjkim@dpw.lacounty.gov

**Signatures**

By_____ Date_____
Name:
Title:

By_____ Date_____
Name:
Title:

By_____ Date_____
Name:
Title:

## ENCLOSURE B

Project Funding Agreement 04299
"In-Situ Arsenic Removal on Unsaturated Alluvium"
between
Water Research Foundation ("Foundation"),
the Co-Funding organization(s) ("Co-funders") detailed on Exhibit C, and
Los Angeles County DPW-Waterworks District ("Sub-recipient")

This Joint Project Funding Agreement (hereafter "PFA") is between the Water Research Foundation, (hereafter "Foundation"), a Delaware non-profit corporation whose principal place of business is located at 6666 W Quincy Ave., Denver, Colorado 80235, the organization(s) detailed on Exhibit C of this PFA (hereafter referenced as "Co-funders"), and Los Angeles County DPW-Waterworks District (hereafter "Sub-recipient"), whose principal place of business is located at 1000 South Fremont Avenue, Bldg. A, Alhambra, CA 91803-1331

The Foundation and the Co-funders have selected said Sub-recipient to receive a research and development grant as more specifically detailed in this PFA.

The parties mutually agree as follows.

## I. DEFINITIONS

For purposes of this PFA, the terms and definitions detailed below, and throughout this PFA shall control

**A.** "Co-funders" is the entity(ies) as more specifically described on Exhibit C. All entities referenced as Co-funders shall be defined to include all officers, directors, employees, volunteers, independent contractors, affiliates, agents, and related entities of each such Co-funder

**B.** "Cost Share" is goods or services provided by an organization dictated by the cost principles that are applicable by their cognitive agency

**C.** "Cure Period" is a complete or permanent solution or remedy that is completed in a cycle, a series of events, or a single action.

**D.** "Co-Principal Investigator" is a Sub-recipient's employee or a subcontractor as specifically designated herein who works with the Principal Investigator in the scientific development or execution of the Project. A Co-Principal typically devotes a specified percentage of time to the Project.

**E.** "Derivative Work" is defined as a work of authorship that is based on any pre-existing written report, study, test result, or other work of authorship, and that modifies, transforms, or recasts that pre-existing work so as to alter it in any way

**F.** "Educational Purpose" is defined as any non-commercial and non-profit use of Intellectual Property as defined by Paragraph I.H, including, but not limited to, a Foundation or Co-funders owned publication or report utilized as a research tool and/or reference, to inform the drinking water community, water utility personnel, or the general public of the outcome of this Project.

**G.** "Foundation" is a non-profit organization organized to sponsor practical applied research on behalf of the drinking water industry through funding research and development regarding the subject of drinking water It shall be defined to include all officers, directors, employees, volunteers, independent contractors with the exception of the Sub-recipient, Subcontractors, and Co-funders), affiliates, agents, and related entities of Foundation.

**H.** "Intellectual Property" is defined as all inventions, innovations, creations, works, reports, figures, tables, processes, designs, methods, formulas, drawings, plans, technical data, specifications, logos, computer programs, computer chips and circuits, whether or not protectable through patent, copyright, trademark, or mask work and whether produced in any medium now known or hereafter produced or developed.

**I.** "Participant "is defined as an individual or organization that provides third party contributions or other material support to the Foundation research Project but does not enter into a contractual relationship with the Foundation, the Sub-recipient, or Subcontractor.

**J.** "Principal Investigator" is defined as the Sub-recipient's employee, as specifically designated in Section III.B herein, with primary responsibility for ensuring that all terms and conditions of this PFA are met and to whom the Foundation shall give all Notices (*See* XIV.P), including, but not limited to, Notice of insufficiencies.

**K.** "Program Income" is defined as gross income earned by the Sub-recipient that is directly generated by a supported activity or earned as a result of the award.

**L.** "Project" is defined as the work to be completed by the Sub-recipient and any Subcontractors pursuant to this PFA and as described more specifically in the Project Proposal.

**M.** "Project Advisory Committee" or "PAC" is defined as a group of independent volunteers who are not controlled by the Foundation or Co-funders and who are gathered by the Foundation and Co-funders to provide technical review, assistance, and/or expertise to the parties regarding the Project.

**N.** "Project Managers" are defined as Foundation's employee(s) and the Co-funders' employee(s), as specifically designated herein in the Proposal Guidelines found on the Foundation's website, www waterresearchfoundation.org/research/projectadmin/proposalguidelines, with joint responsibility for all contact with the Sub-recipient and as having authority to communicate all the Foundation and Co-funders' decisions concerning the Sub-recipient's Project.

**O.** "Project Proposal" is defined as the initial request by the Sub-recipient for funding and shall include all relevant correspondence and/or other written communications subsequent to that request but prior to the execution of this PFA.

**P.** "Sponsor" is a qualified sponsoring utility that shows financial and conceptual support to the research for a Project.

**Q.** "Sub-recipient" is defined as the named individual(s) and/or entity(ies) described in the introductory paragraph of this PFA or the party(ies) entering into this PFA with the Co-funders. The singular form of Sub-recipient shall include all individuals and entities detailed herein. The Sub-recipient shall include all officers, directors, employees, affiliates, and agents of the Sub-recipient.

**R.** "Subcontractor" is defined as any individual or entity, with whom the Sub-recipient shall separately contract, to complete one or more specific tasks required by the Project.

## II. SERVICES TO BE PROVIDED

**A.** Sub-recipient. The Sub-recipient agrees to complete research and prepare written reports as detailed by Exhibit B based upon the Project Proposal attached as Exhibit A. The deliverable schedule for these reports is outlined in Exhibit B to this PFA.

**B.** Foundation and Co-funders: Foundation and Co-funders will provide funds as available and as detailed by Exhibit C attached for activities detailed by the Project Proposal. Co-funders will provide all funds designated in full to the Foundation as detailed by Exhibit C; the Foundation shall make all disbursements to Sub-recipient.

## III. KEY CONTACTS

**A.** Foundation Key Contacts:

- Hsiao-Wen Chen, Project Manager, Water Research Foundation, 6666 W Quincy Ave., Denver, CO 80235, Phone: (303) 347-6103, and Email: hchen@waterresearchfoundation.org.
- Peggy Falor, Contract Administrator, Water Research Foundation, 6666 W Quincy Ave., Denver, CO 80235, Phone: (303) 734-3424, and Email: pfalor@waterresearchfoundation.org.

**B.** Sponsor and Sub-recipient Key Contacts:

Principal Investigator

- T.J Kim, Los Angeles County DPW Waterworks District, PO Box 1460, Alhambra, CA 91802-1460, Phone: (626) 300-3327, and Email tjkim@dpwlacounty.gov

Authorized Representative

- Dan Lafferty, Los Angeles County DPW-Waterworks District, PO Box 1460, Alhambra, CA 91802-1460, Phone: 626-300-3302 , and Email dlaff@dpw.lacounty.gov

Accounting Contact

- T.J Kim, Los Angeles County DPW Waterworks District, PO Box 1460, Alhambra, CA 91802 1460, Phone: (626) 300-3327, and Email. tjkim@dpwlacounty.gov

**C.** Co-Principal Investigator Key Contacts:

- John Izbicki, U.S. Geological Survey, 4165 Spruance Road, Suite 200, San Diego, CA 92101, Phone: (619) 225-6131, and Email. jaizbick@usgs.gov

Each party shall provide written Notice of changes in contact persons, addresses, telephone, fax, and email addresses. Changes or substitutions for the Principal Investigator, Co-Principal Investigator, or any other Subcontractor require prior written approval from Foundation as identified in Paragraph

XIV G

1 The Foundation and Co-funders will make mutually agreed management decisions regarding this PFA and the Project. In the event a disagreement arises and the parties are unable to resolve it between themselves reasonably and in good faith and/or with the advice of the PAC, the Foundation shall have final decision-making authority (*See* XIII.A).

2. The PAC shall be composed of an independent group of volunteers that are technically expert individuals the number which will be determined by Foundation.

## IV. PFA PERIOD

**A.** Period. This PFA shall be effective for the period commencing on May 15, 2010 and ending on April 15, 2014. Neither the Foundation nor the Co-funders shall have any obligation for payment of services rendered by the Sub-recipient that are not performed within this specified period.

**B.** Time of Performance: Sub-recipient shall complete all Project tasks, reports, and other obligations according to the performance schedule detailed in Exhibit B (which may be amended from time to time upon mutual agreement of the parties) in this PFA

## V. FUNDING

**A.** Source of Funds. All funds provided come from the Foundation and Co-funders solely

**B.** Condition for Receipt of PFA Funds. Funds provided to the Sub-recipient under this PFA may not be used by the Sub-recipient as a match or cost-sharing provision to secure U.S. Federal monies or money from any other sources without prior written approval by Foundation. The Foundation approves the use of a portion of LADPW contribution as a match or cost-sharing provision to secure USGS contribution of $135,000 USD.

**C.** Maximum Amount Available: The Foundation agrees to provide grant money to the Sub-recipient in an amount not to exceed one hundred fifty thousand US dollars ($150,000) for the completion of this PFA if not terminated early (*See* XIV.E). Further, the Co-funders agree(s) to provide money to the Sub-recipient, as more specifically detailed by Exhibit C, for further distribution to the Sub-recipient in a total amount not to exceed four hundred thirty-eight thousand US dollars ($438,000) for the completion of this PFA if not terminated early (*See* XIV.E). The Sub-recipient, the Subcontractor, and the Participant agree to provide two hundred thirty thousand four hundred sixty-four US dollars ($230,464) cost share and one hundred eighty thousand US dollars ($180,000) in in-kind contributions as detailed in Exhibit C. For a Project total budget of nine hundred ninety-eight thousand four hundred sixty-four US dollars ($998,464).

**D.** The Foundation will not manage all of the cash funds for the Project. All parties will retain their own portion of cash funds for the Project. The Sub-recipient will be responsible for managing and reporting their contribution of funds through the invoice schedule described in Exhibit B. All Sub-recipient funds will be expended first before the Foundation's funds are spent toward this Project. No cash advance will be awarded to the Sub-recipient.

## VI. STATUTES AND REGULATIONS

**A.** Sub-recipient is solely responsible for obtaining, reviewing and understanding all U.S. Federal, State, and local ordinances, rules, regulations, and statutes applicable to this PFA and Project, which ordinances, rules, regulations and statutes, as amended from time to time, are hereby included by this reference in this PFA.

## VII. PAYMENT TERMS AND CONDITIONS

**A.** Advance Payment: No advance will be paid to the Sub-recipient, see V. Funding.D.

**B.** Budget: The PFA Budget, attached as Exhibit C, shall constitute the maximum amount available to the Sub-recipient for work performed under this PFA.

**C.** Payment of an Invoice: Payments are based on submission and acceptance the Periodic Report to the Foundation and Co-funders each as defined in the Foundation "Proposal Guidelines" or "Tailored Collaboration Guidelines" (depending on the type of proposal submitted) which Guidelines are hereby made part of this PFA by reference (*See* http://www.water researchfoundation.org/research/ProjectAdmin/docs/solicited.pdf). Payments are based on submission and acceptance the Periodic Report as defined in the Foundation's "Proposal Guidelines." No payment will be disbursed by the Foundation unless and until each Periodic Report is received and accepted by the Foundation (such acceptance not to be unreasonably withheld). The periodic report content and format document has been posted as guidance for PIs on the "Project Guidelines" web page: http://www.waterresearchfoundation.org/research/projectAdmin/projectGuidelines.aspx

An invoice detailing expenses incurred during the reporting period must be submitted to the Foundation every three (3) months in accordance with Exhibit B. The Sub-recipient invoice must also detail all cost-share and third party in-kind (if available) for each reporting period. Each invoice should be displayed according to the budget line items in Exhibit A. All invoices must be submitted using the form shown in Exhibit D and must be on the Sub-recipient's letterhead. Sub-recipient shall be paid as follows:

1 Ten percent (10%) of the total funding will be held back from Sub-recipient until (a) receipt of an acceptable draft report, as defined on the Foundation 's website "Proposal Guidelines." Another ten percent (10%) will be held back from Sub-recipient until Sub-recipient responds to subsequent editor queries on the final report, as defined on the Foundation's website "Proposal Guidelines," and submission of a final invoice detailing final Project costs including cost share and in-kind contributions. All funding is contingent upon actual costs incurred.

2. The payment of an invoice by the Foundation shall not prejudice Foundation's right to object to or question any invoice or matter relating to invoices submitted in accordance with this PFA. Payment by the Foundation shall not be construed as acceptance of any part of the work or service provided.

**D.** Unallowable Costs: The Sub-recipient's invoice shall be subject to reduction for amounts included in any invoice or prior payment made which are determined by the Foundation not to constitute

allowable costs on the basis of audits, reviews, or monitoring of this PFA in accordance with Foundation's standards and any applicable Federal Uniform Administrative Requirements applicable to this PFA.

**E.** Deductions & Withholdings:

1 Foundation may deduct amounts or withhold payments invoiced by the Sub-recipient if the Sub-recipient fails to comply with any Foundation standard and/or Federal Uniform Administrative Requirements applicable to this PFA based upon the Sub-recipient's cognitive agency

2. Funds withheld due to unsatisfactory compliance with any Foundation standard and/or Federal Uniform Administrative Requirements (based on Sub-recipient's cognitive agency) may be restored upon satisfactory correction or completion of the condition that caused the withholding.

## VIII. STANDARDS FOR FINANCIAL MANAGEMENT

**A.** Financial Management System.

1 The Sub-recipient will maintain an accounting system and a set of accounting records that, at a minimum, allow for the identification of individual Projects by source of revenue and expenditures related to this PFA.

2. All costs will be supported by source documentation and be made available to the Foundation upon request.

3 The Sub-recipient's accounting records will be the basis for generating financial reports that must reflect accurate and complete data. In addition, financial records must be properly closed out at the end of the PFA period and all reports submitted in a timely manner

**B.** Cost Principles: Without regard to US Federal Funds being provided for this Project, for each type of Sub-recipient organization, there is a set of Federal cost principles for determining allowable costs with which principles the Sub-recipient agrees to comply and which principles are hereby included by this reference in this PFA unless such principles are modified by this PFA. Allowable costs are determined in accordance with the cost principles applicable to the type of organization incurring the costs. The following is a non-exclusive example of a list of organization types and the applicable cost principles to be used

- State, local or Indian tribal government, OMB Circular A-87
- Non-profit Organization (NPO), 2 CFR 230
- Institution of Higher Education, 2 CFR 220
- Hospitals, 45 CFR 74
- Commercial (For Profit) and selected Non-Profit Organizations.

**C.** Indirect Costs and Allocation of Costs.

1 If the Sub-recipient charges indirect (overhead) costs to the PFA, an "Indirect Cost Proposal" must be prepared in accordance with the applicable cost principles referenced in Paragraph VIII.B

2. For payment of indirect costs by the Foundation the Sub-recipient must provide a written statement for proof of an approved indirect cost rate from the L.A. County Auditor-Controller attesting that the proposal complies with the requirements of the applicable cost principle as required by VIII.B above and which statement provides the basis of the calculated rate.

## IX. PROCUREMENT STANDARDS

**A.** Procurement Standards:

1 As with Cost Principles (VIII.B above), the parties adopt the U.S. Federal standards for procurement as are outlined in the U.S. Federal Uniform Administrative Requirements applicable to the organization type to which the Sub-recipient belongs, and Sub-recipient's compliance with those standards is required under this PFA (See VI) except as may be modified by this PFA.

2. These provisions define the standards for use in establishing procedures for procurement of supplies, equipment, and other services which cost is borne in whole or in part as a condition of this PFA.

3 These standards include but are not limited to the following:

a. Sub-recipient may use its own procurement policies provided that they adhere to the applicable standards;

b. Sub-recipient shall maintain a code of conduct which shall govern the performance of its officers, employees, and agents (including Subcontractors) in contracting with or expending Foundation and Co-funders' funds; and

c. All procurement transactions shall be conducted in a manner so as to provide for maximum open and free competition.

**B.** Title to Equipment and Supplies:

1 Sub-recipient shall assume responsibility for the care and maintenance of all equipment or supplies acquired for use in the Project pursuant to current Sub-recipient policy and manufacturer's instruction.

2. Title to any equipment and supplies for this Project shall be vested to Sub-recipient.

## X. AUDITS AND MONITORING|

**A.** Audit Procedures: The expenditure of funds under this PFA may be subject to quarterly or annual audits conducted by the Foundation on behalf of itself and Co-funders, in Foundation's sole discretion, or by its authorized representatives. The Sub-recipient shall provide to the Foundation and its authorized representatives all technical staff, assistance, and information needed to enable Foundation to perform its auditing function. This assistance includes, but is not limited to, information about the Sub-recipient's Project in-kind and money grants, expenditures, operation,

accounting, and database systems.

**B.** Monitoring:

1 The Sub-recipient may receive on-site reviews from the Foundation or its authorized representatives, in addition to review(s) from Federal government personnel. Monitoring staff may review Project and/or financial activity relating to the terms of this PFA. Upon request, Foundation or its authorized representatives shall be given full and complete access to all pertinent information related to the performance of this PFA.

2. The Sub-recipient shall provide to the Foundation and its authorized representatives all technical staff, assistance, and information needed to enable the Foundation or Federal government personnel to perform their monitoring function. This assistance from the Sub-recipient includes, but is not limited to, information about the Sub-recipient's Project operation, accounting, and database systems.

**C.** Program and Financial Deficiencies:

1 Through audits, reviews, monitoring, or other means, the Foundation may find the Sub-recipient to have program or financial deficiencies in the performance of the PFA. Such deficiencies may include, but are not limited to, the areas of accounting, financial controls, budgeting, and/or Project compliance issues. If deficiencies are found, the Foundation may exercise its rights to terminate this PFA or may require the Sub-recipient to take corrective action and to submit a written corrective action plan to address identified deficiencies. All corrective action plans must be accepted by the Foundation or its authorized representatives. Any corrective action must be satisfactorily completed within the 30 (thirty) days "cure period" if such a cure period is provided (*See* XIV.E.1).

2. The Foundation in its sole discretion may require Sub-recipient to submit additional periodic written verification that measures have been taken to implement the corrective action. If the Sub-recipient fails to demonstrate its compliance with the approved corrective action plan within the time constraints set by the Foundation in its sole discretion, the Foundation may exercise its rights to terminate this PFA. The Foundation may also exercise any of the other rights and remedies available to it at law or in equity

## XI. REPORTS AND RECORDS

**A.** Required Deliverables: Required Project deliverables are described in the Foundation "Proposal Guidelines" and are listed in Exhibit B

1 Sub-recipient will provide Co-funders with a copy of all Periodic, Interim, Draft, and Final Reports arising from the Project. Further, the Foundation will decide who will publish the Final Project Report, who will oversee such publication, and in what language it will be published. The Foundation will decide the mode of publishing (print, electronic, or other). Co-funders will each receive ten (10) copies of the final printed report.

2. In the event the Foundation decides to electronically publish a Report, it will provide the Co-funders with a complete *PDF* file of the Report in the English language prior to general publication to subscribers or outside third parties. The parties agree that each may place a *PDF* version of the full Final Report on its own web site, if any, after the Foundation has provided such Report to its subscribers. No drafts shall be published by the Co-funders.

**B.** Record Retention.

1. Sub-recipient shall retain all financial records, supporting documents, statistical records, and all other records pertinent to this PFA and the Project referenced herein for a period of three (3) years from the date of payment of final invoice.

2. If any litigation, claim, or audit is started before the expiration of the three (3) year period, the records shall be retained until all litigation, claims, or audit findings involving the records have been resolved and final action taken.

**C.** Access to Records:

1 The Foundation, the Co-funders, and their authorized representatives, have the right of timely and unrestricted access to any books, documents, papers, or other records of the Sub-recipient upon forty-eight (48) business hours Notice in order to perform audits, monitoring reviews, or other types of site visits during regular operating hours of Sub-recipient.

2. The rights of access to Sub-recipient's records also includes timely and reasonable access to the Sub-recipient 's available past and present personnel for the purpose of interviewing and disclosing matters related to such documents.

3 The right of access to Sub-recipient's records is not limited to the required three (3) year period.

4. Sub-recipient waives any confidentiality, privacy privilege, or proprietary defenses consistent with the California Public Records Act, regarding audits or monitoring by the Foundation (or its representatives). the Foundation will keep any of Sub-recipient's proprietary technical and/or scientific information confidential if such material is appropriately marked as "Confidential," is not already in the public domain prior to disclosure, is not required to be disclosed as a result of court order, legal process or government action or applicable law of regulation, or was already known to others not under a requirement to maintain its confidentiality

## XII. INTELLECTUAL PROPERTY AND PUBLICATION

**A.** Proprietary Rights to Intellectual Property· The Foundation's and Co-funders' primary purpose in funding the Sub-recipient is to further scientific and technological knowledge in the area of research covered by this Project. As such, certain written works and copyrightable computer software programs created during the course of this PFA are to be owned by the Foundation and licensed to Co-funders while patented inventions or inventions in the process of being patented, created by the Sub-recipient, including software inventions, made under this PFA shall be owned by the Sub-recipient and other created Intellectual Property are to be owned by all the parties jointly as more specifically delineated below

**B.** Foundation Intellectual Property: The Parties intend that the Foundation shall own all U.S. and world-wide copyright in the Scope of Work, all Periodic Reports, all Draft Reports, the Final Report, and the Project Profile, all drafts of these works and reports, and all non-patented computer software developed as a deliverable for this Project as defined in the Foundation's "Tailored Collaboration Guidelines," and in Exhibit A. Such property is hereby assigned to the Foundation (hereafter "Foundation Intellectual Property"). No Foundation Intellectual Property shall be utilized or distributed by the Sub-recipient or Co-funders or any Subcontractor in any manner without Foundation's prior written approval, except for Educational Purposes as defined in I.F The Sub-recipient shall execute whatever additional documents are necessary in order to comply with this Paragraph (*e.g.*, a U.S. Copyright Office application or other world-wide application for copyright protection, or short form license or assignment agreement(s) for recordation) (*See* Exhibit E Assignment of Copyright).

1 The Foundation hereby grants the Sub-recipient and Co-funders a royalty free, world-wide, nonterminable, nonexclusive license, without the requirement for any accounting, to utilize Foundation's Intellectual Property solely for Educational Purposes as defined in Paragraph I.F above except as restricted by this PFA (*See* XI.A.2).

2. While Sub-recipient and Co-funders may not utilize any Foundation Intellectual Property for other purposes without prior written permission from the Project Manager, reasonable requests to present or publish portions of the Foundation Intellectual Property will be seriously considered as the Foundation is highly interested in the distribution of the information developed through this PFA.

**C.** Sub-recipient's Intellectual Property: All patented inventions and improvements (or in the process of being patented) shall be considered Sub-recipient's Intellectual Property, including, but not limited to, the right to file for patent registration. The Sub-recipient shall be responsible for any and all disclosures required to the U.S. Government. If the Sub-recipient intends to, or does, abandon its rights to any of Sub-recipient's Intellectual Property, Sub-recipient shall notify the Foundation of the same and assign to the Foundation those rights upon timely request. Sub-recipient shall not withhold any findings based on Sub-recipient Intellectual Property, patentable or otherwise, from works and reports, as defined in the Foundation's "Proposal Guidelines," and in Exhibit A. The Sub-recipient shall have the burden of demonstrating the existence of confidential information and/or trade secrets should it designate information as such by legend. If the Sub-recipient is using an existing patent or pre-existing patented material owned by another party, the Sub-recipient must have mentioned the same in Sub-recipient's Project Proposal as attached as Exhibit A and must obtain written permission to use the patent on this Project. Copies of any permission or licenses granted shall be provided to the Foundation upon execution. All permission must be provided to the Foundation prior to completion of any Draft of the Final Report. The Sub-recipient hereby grants the Foundation and its subscribers a nonterminable, world-wide, nonexclusive license to utilize such Intellectual Property for non-commercial (i.e., non-profit or educational) purposes, without royalty, and without the requirement of an accounting to Sub-recipient for any such use. Should Sub-recipient wish seek patent protection for any such Intellectual Property, neither the Foundation nor its subscribers shall be held responsible in any manner for Sub-recipient's failure to timely protect its patent rights or the patentability of any Intellectual Property

**D.** Jointly Owned Intellectual Property: For the purpose of allowing Foundation, Co-funders, and the Sub-recipient to make full use of all Intellectual Property developed during the course of this Project that is not defined above as owned by either party solely; certain Intellectual Property shall be considered Jointly Owned Intellectual Property

1 Jointly Owned Intellectual Property is defined as (a) all Intellectual Property developed during the term of, and pursuant to, this PFA which is not defined above as Foundation Intellectual Property, Sub-recipient's Intellectual Property, or as U.S. Government Intellectual Property, if applicable, (b) all scientific information and data reported such as innovations, creations, processes, designs, methods, formulas, plans, technical data, and specifications; and (c) the Project Proposal, excluding the statement of qualification and resumes.

2. The Sub-recipient hereby assigns to the Foundation and Co-funders an undivided equal share to such Jointly Owned Intellectual Property, including the right to apply for copyright registration with the U.S. Copyright Office or similar official repositories throughout the world. The Foundation, Co-funders, and the Sub-recipient may each utilize such property, without royalty to the other, for any and all purposes throughout the world without any requirement of an accounting. Further, the Sub-recipient and Co-funders hereby grants to the Foundation's subscribers a nontransferable, nonterminable, and nonexclusive license, without royalty, and without any requirement for an accounting, to utilize Jointly Owned Intellectual Property throughout the world. The Sub-recipient shall execute whatever documents are required in order to comply with this Paragraph, including, but not limited to, assignments as necessary for any world-wide copyright protection (*See* Exhibit E).

**E.** Pre-existing Intellectual Property: In the event Sub-recipient owns Intellectual Property that was developed prior to this PFA and that pre-existing Intellectual Property is utilized for this Project, such Intellectual Property shall remain the property of Sub-recipient; however, the Foundation, its subscribers, and Co-funders are granted a nonterminable, world-wide, nonexclusive license, without royalty, and without the requirement of an accounting to Sub-recipient, to utilize such information for non-commercial (i.e., non-profit or educational) purposes. In the event Sub-recipient utilizes Intellectual Property owned by another in this Project (including any Foundation Intellectual Property), Sub-recipient shall obtain all appropriate permissions on Foundation's and Co-funders's behalf for the publication of such materials in any form or format, including, but not limited to, compilations without the requirement of any royalty or accounting. Agreements detailing such permissions shall be approved by, and completed documents shall be provided to the Foundation.

**F.** Publication of Intellectual Property: The Foundation encourages the Sub-recipient and Co-funders to publish Jointly Owned Intellectual Property based on this Project and to utilize the Foundation's Intellectual Property for Educational Purposes. Any publication of Foundation Intellectual Property must comply with the requirements of this PFA. The Sub-recipient agrees to comply with the following steps prior to such distribution, presentation, or publication.

1 The Sub-recipient and Co-funders hereby agree to provide to the Foundation copies of any publication or presentation of Jointly Owned Intellectual Property or Foundation Intellectual

Property approved for publication/presentation at least three (3) weeks prior to submission of such publication or presentation.

2. Each party agrees and understands that it shall not dispose of or injure another's rights to Jointly Owned Intellectual Property or the Foundation's rights to Foundation Intellectual Property, including, but not limited to, any computer software by any presentation or publication of such property and shall take all steps necessary to preserve the owner's rights. This Paragraph shall not prevent the Sub-recipient, Co-funders, or the Foundation from transferring its own undivided but equal share of ownership of Jointly Owned Intellectual Property to a publication without any requirement of royalty or accounting to the others.

3 In the event the Sub-recipient or Co-funders publishes Jointly Owned Intellectual Property and is required by the publisher to assign its copyright ownership to the work, the Sub-recipient and Co-funders agree to include the following or similar language on any copyright assignment: *The submitted manuscript [publication] [presentation] has been made possible through funding from the Water Research Foundation and Los Angeles County DPW-Waterworks District. The information contained herein is based upon Intellectual Property that is jointly owned by Los Angeles County DPW Waterworks District and the Water Research Foundation. The Water Research Foundation and Los Angeles County DPW-Waterworks District retain their rights to publish or produce the Jointly Owned Intellectual Property in part or in its entirety*

4. Sub-recipient agrees to acquire appropriate permission(s) to use any third-party copyrighted materials utilized in any manner in connection with the Project (*See* XII.E. above). The permission needs to cover both print and electronic versions of a report that will be published by Foundation and/or third party Reference the Foundation's Format-Style Guide Chapter 4: Use of Copyrighted Material. The Sub-recipient should complete the copyright permission letter that is located on the Web at http://www.waterresearchfoundation.org/research/projectAdmin/docs/SampleLetter.doc Sub-recipient agrees to provide full ownership and license information for any such materials; and the Foundation agrees to include appropriate acknowledgements for all original sources in published Foundation Intellectual Property

**G.** Student Thesis: In the event a college or graduate student is employed by Sub-recipient to work on the Project contemplated by this PFA and that student completes a thesis, dissertation, or report relating to this Project, solely for Educational Purposes, the student shall own the copyright in that thesis or report, to the extent necessary for publication while not injuring the Foundation's or Co-funders' rights, and such rights shall be reserved to the student in any assignment document or form subsequently executed. In the event a portion of the Foundation Intellectual Property or Jointly Owned Intellectual Property is included in that thesis or report, the Foundation and Co-funders hereby grant the student a nonexclusive license to utilize that the Foundation Intellectual Property for the specific thesis or report for Educational Purposes.

**H.** Copyright Notice: Any Jointly Owned Intellectual Property, or Derivative Works thereof, utilized by the Sub-recipient , Co-funders, or the Foundation shall include a United States' copyright notice of ownership as detailed below:

Copyright [year of publication], Water Research Foundation and

Los Angeles County DPW-Waterworks District
ALL RIGHTS RESERVED
No part of this article may be copied, reproduced, or otherwise utilized without permission.

- Any Foundation Intellectual Property must contain the following copyright notice:

Copyright [year of publication], Water Research Foundation
6666 W Quincy Avenue, Denver, CO 80235
ALL RIGHTS RESERVED
No part of this article may be copied, reproduced, or otherwise utilized without permission.

**I.** Sub-recipient 's/Co-funders's Acknowledgement: Any public presentation or publication by the Sub-recipient or Co-funders, including a student writing a thesis, dissertation, or report, based on the parties' Jointly Owned Intellectual Property, Sub-recipient 's Intellectual Property, or any portion of Foundation Intellectual Property, shall include the following, or a similar, statement acknowledging the Foundation and Co-funders, as appropriate, for providing financial and administrative support: *Los Angeles County DPW-Waterworks District gratefully acknowledges that the Water Research Foundation, and Los Angeles County DPW-Waterworks District are co-owners of certain technical information upon which this publication [manuscript] [presentation] is based. Los Angeles County DPW-Waterworks District thanks the Water Research Foundation, for their financial, technical, and administrative assistance in funding the project through which this information was discovered.*"

**J.** Disclaimer: Any publication and presentation by Sub-recipient or its students utilizing the Foundation Intellectual Property or the Jointly Owned Intellectual Property shall include the following disclaimer: *The comments and views detailed herein may not necessarily reflect the views of the Water Research Foundation, its officers, directors, affiliates or agents* Every Project Report shall contain (a) the Foundation logo and Co-funders logo, (b) an acknowledgment that the Foundation and Co-funders are co-sponsors of the publication, material, and its underlying research, and (c) a disclaimer which states: "*This document was reviewed by a panel of independent experts selected by* the *Foundation.* The *Foundation and Los Angeles County DPW Waterworks District assume no responsibility for the content of the research study reported in this publication or for the opinions or statements of fact expressed in the report. Mention of trade names or commercial products does not constitute* the *Foundation's, Los Angeles County DPW Waterworks District's endorsement or recommendations for use. Similarly, omission of products or trade names indicates nothing concerning the Foundation's, or Los Angeles County DPW-Waterworks District's position regarding product effectiveness or applicability This report is presented solely for informational purposes.*"

**K.** Return of Intellectual Property: The Sub-recipient shall provide to Foundation legible copies of all the Foundation's Intellectual Property and shall provide to Foundation and Co-funders legible copies of all Jointly Owned Intellectual Property and licensed pre-existing Intellectual Property within thirty (30) days of receiving a Notice of termination (including source and object code of any computer software program) whether or not a cure period is provided. Further, at the same time, Sub-recipient shall provide copies and originals where the Sub-recipient has abandoned, or otherwise lost, its rights to patentable inventions or discoveries, as provided by 37 CFR 401 et.seq. Such information shall be provided in whatever medium is reasonably designated by the Foundation. No final payments will be made without proper provision of such Intellectual Property

**L.** Originality· The Sub-recipient shall verify and ensure that it, and its Subcontractors, are the sole creator(s) and originator(s) of all Foundation Intellectual Property, Sub-recipient's Intellectual Property, pre-existing Intellectual Property, and Jointly Owned Intellectual Property as defined herein, none of those rights have been bargained, sold, or conveyed in any other manner to any person or entity except as detailed and permitted by this PFA. Further, the Sub-recipient shall use its best efforts to ensure that no portion of this Project, including any portion completed by Subcontractors, infringes upon the Intellectual Property rights of any other person or entity or violates the common law or statutory right, title, or interest of any person or entity

**M.** Background Intellectual Property. This PFA shall not be construed as implying that either party hereto shall have the right or license (express or implied) to use background Intellectual Property of the other in connection with this Project except as otherwise provided hereunder or required by Federal government regulations. Background Intellectual Property includes property and the legal right therein of either party developed before or independent of this PFA or the Project including inventions, patent applications, patents, copyrights, trademarks, mask works, trade secrets, know-how and any information embodying proprietary data such as technical data and computer software.

**N.** Other Research. The Foundation understands that Sub-recipient may be involved or become involved in similar or related research on behalf of itself and others. Subject to any confidentiality and Intellectual Property sections of this PFA, nothing contained in this PFA shall be construed to limit or impair the freedom of Sub-recipient or its researchers neither to conduct research for itself or third-parties nor to grant the Foundation any right to such other research or Intellectual Property, created as a result of the same.

**O.** The terms of this Section XII shall survive the termination of this PFA.

## XIII. DISPUTE RESOLUTION

**A.** In the event Foundation and Co-funders are unable to resolve a dispute between themselves relating to the Sub-recipient, the Sub-recipient's actions or omissions, or the procedure, process, or research concerning the Project, Foundation shall be empowered to make the final determination after reasonably consulting with the PAC.

**B.** In the event Sub-recipient and the Foundation or Sub-recipient and Co-funders have a dispute between themselves relating to this PFA, the Project, or a party's actions or omissions not related to the enumerated matters in Paragraph XIII.A, and if the parties involved are not able to resolve their dispute within sixty (60) days of Notice of the dispute being provided by a party to the others, the parties involved in the dispute agree to submit their dispute to mediation.

**C.** In the event mediation is required, the parties shall jointly choose a single mediator located in Denver County, Colorado U.S.A. who is skilled in the subject matter of their dispute. In the event they are unable to jointly choose a mediator, the disputing parties shall each choose a mediator, which two mediators shall jointly choose a third mediator – also located in Denver County · who will hear and decide the dispute.

**D.** All parties will pay equally for the mediators' services.

**E.** A mediator shall be chosen and mediation shall be scheduled no later than forty-five (45) days after the Notice of dispute is received. Mediation shall be completed no later than ninety (90) days after the Notice of dispute is received. During the period of dispute, no party shall take any action that which would injure the interests of another party or delay the Project.

**F.** Mediation shall last no longer then four (4) business days unless agreed upon in writing by the parties. During the mediation period, documents submitted to the mediator and statements made during the mediation, including proposed settlement terms, are for settlement purposes only and shall remain confidential. However, evidence otherwise admissible or discoverable shall not be rendered inadmissible or undiscoverable because of its use in the mediation.

**G.** If the parties are unable to reach a reasonable business decision on their own with the assistance of the mediator by the end of the mediation session, the mediator shall choose an Arbitrator located in Denver, Colorado U.S.A. to hear the parties' dispute. The Arbitrator's decision shall be binding on both parties. During this arbitration process,

1 The Arbitrator shall have subpoena powers.

2. The American Arbitration Association ("AAA") and Colorado Civil Procedure Rules, where not in conflict with the AAA Rules, which are in effect at the time the Notice of dispute is received shall apply

3 Any final binding determination issued by the Arbitrator shall be in writing within thirty (30) days of the final mediation session.

4. Such written decision may be entered as an Order of the Court with proper jurisdiction.

**H.** This Section XIII shall survive the termination of this PFA.

## XIV. STANDARD TERMS AND CONDITIONS

**A.** Standard terms, which by their nature and intent may continue beyond the termination of the PFA, shall survive the termination of this PFA.

**B.** Accuracy of Testing/Quality Assurance: The Sub-recipient shall use its best efforts to ensure that all data and test results developed during the course of this PFA and included, or relied upon, in the Final Report are accurate to the best of its knowledge, information, and belief. In the event the Sub-recipient obtains any data, test results, information derived from such data or test results, or other information to be included in the Project from water utilities or any Subcontractor, the Sub-recipient will utilize reasonable and customary efforts to ensure the accuracy of the information obtained.

**C. Co-funders Review:** The Sub-recipient shall (a) grant the Co-funders the right to review the Project's use and conclusions concerning that organization's data and/or test results, if any, and (b) provide the Co-funders with the reasonable opportunity to correct, or if correction will take an unreasonably long time, to respond to any problems or difficulties uncovered by the data, information, or test results, all of which must occur prior to the publication or use of such information. This provision shall apply to each Co-funder in any manner with the Project, including, but not limited to, providing services, data, materials for testing, test results, and/or documentation. The Sub-recipient

shall be responsible for providing letters for review and execution by each Co-funder confirming that they have been made aware of the nature of the cooperative relationship and have reviewed all applicable data, information, or results as described in this Paragraph. Letters of confirmation, signed by a representative for and each Co-funder, must be received by Foundation with submittal of the Final Report (Exhibit B). If the Sub-recipient has made reasonable efforts but is not able to obtain a Letter of Confirmation with the signature of a representative for the Co-funders, the Principal Investigator may submit a signed letter stating this fact and further stating that the Co-funders were provided reasonable opportunity to correct or respond to any problems or difficulties as stated above.

**D.** Responsibilities: The responsibilities detailed by this PFA in order to protect the parties' Intellectual Property rights shall continue throughout this PFA and shall survive the termination of this PFA. Further, in addition to the responsibilities detailed elsewhere in this PFA, each of the parties shall have the responsibilities detailed below·

1 Responsibilities of Foundation. If the Sub-recipient experiences any problems relating to the completion of this Project or PFA from third parties, including, but not limited to, liabilities, obligations, damages, losses, costs, claims, lawsuits, causes of action, or demands, including any attorneys' fees and costs, the Foundation's sole obligation will be to provide evidence of this PFA and the grant provided. the Foundation will be responsible only for proven direct damages caused directly by its then current insured actions or omissions in breach of this PFA and not special, consequential, or other damages, or any attorneys' fees or costs, whether known or not. In no event shall any damages exceed the amounts actually provided to Sub-recipient by the Foundation, exclusive of Co-funders' monies, through this PFA.

2. Responsibilities of Co-funders. If the Sub-recipient experiences any problems relating to the completion of this Project or PFA from third parties, including, but not limited to, liabilities, obligations, damages, losses, costs, claims, lawsuits, causes of action, or demands, including any attorneys' fees and costs, Co-funders' sole obligation will be to provide evidence of this PFA and the grant provided. Co-funders will be responsible only for proven direct damages caused directly by its then current insured actions or omissions in breach of this PFA and not special, consequential, or other damages, or any attorneys' fees or costs, whether known or not. In no event shall any damages exceed the amounts agreed to be provided to Sub-recipient by Co-funders, exclusive of Foundation monies, through this PFA.

3 Responsibilities of the Sub-recipient. At all times, all obligations performed by the Sub-recipient or by any Subcontractors pursuant to this PFA shall be performed in a manner consistent with or exceeding the professional standards governing such services. Further, the Sub-recipient shall be responsible for, and shall hold harmless and indemnify the Foundation, Co-funders, and their officers, directors, affiliated organizations, employees, agents, volunteers, and publisher, if any, from any and all liability, obligation, damage, loss, cost, claim, lawsuit, cause of action, or demand whatsoever of any kind or nature, including, but not limited to, attorneys' fees and costs, arising from any actions taken by, or omissions of, the Sub-recipient, its officers, directors, Subcontractors, employees independent contractors, agents, or other related entities or individuals arising from (i) any actions or omissions of the Sub-recipient or its Subcontractors, (ii) any use or misuse of Intellectual Property claimed to be owned by another, or (iii) any material breach of this PFA. Such indemnification shall be in proportion and to the extent liability, obligation, damage, loss, cost claim, lawsuit, cause of action, or demand are caused by or result from the reckless,

intentional, or negligent acts or omissions of the Sub-recipient, its officers, directors, Subcontractors, employees independent contractors, agents, or other related entities or individuals.

4 Public Entities. In the event the Sub-recipient or any Subcontractor is a public entity or quasi-public entity that, by state statute, is not permitted to indemnify others, Paragraph XIV.D 3 are modified to the extent detailed by this Paragraph. Instead, Sub-recipient agrees to be responsible, and will hold all public or quasi-public entity Subcontractors equally responsible, to the fullest extent available under the law, for any and all liability, obligation, damage, loss, cost, claim, lawsuit, cause of action, or demand whatsoever of any kind or nature, including but not limited to, attorney's fees and costs, arising from any actions taken by, or omissions of, the Sub-recipient its officers, directors, Subcontractors, employees, independent contractors, agents or other related entities arising from (i) any use or misuse of Intellectual Property claimed to be owned by another, or (ii) any material breach of this PFA by Sub-recipient. Such fiscal responsibility shall be in proportion and to the extent of liability, obligation damage, loss, or cost claim, lawsuit or action, or demand are caused by or result from the reckless, intentional, or negligent acts or omissions of the Sub-recipient, its officers, directors, Subcontractors, employees, independent contractors, agents, or other related entities or individuals. Further, Sub-recipient agrees to ensure that all individuals or entities or individuals involved in the completion of this PFA that/who may indemnify others are required to so indemnify the Foundation and the Co-funders through a written agreement acceptable to Foundation and the Co-funders.

5 Insurance. The Sub-recipient shall maintain a financially sound program of self-insurance or commercially purchased liability insurance covering unfair competition claims and all reckless, intentional, knowing, and negligent actions or omissions of any and all of Sub-recipient's officers, directors, employees, agents, and independent contractors and/or Subcontractors in the amount of one million dollars ($1,000,000.00). Proof of such insurance shall be presented to Foundation pursuant to the schedule detailed by Exhibit B and to the Co-funders upon request. The proof of insurance document shall clearly specify the Project by number and title on the insurance certificate.

6. Worker's Compensation. The Sub-recipient and all Subcontractors shall maintain Worker's Compensation Insurance which complies with the applicable state laws. Proof of such insurance shall be presented to Foundation pursuant to the schedule detailed by Exhibit B and to the Co-funders upon request.

**E.** Termination. This PFA, except for those provisions which, by their own terms, extend beyond the life of this PFA, shall terminate upon the Foundation providing Notice to the Sub-recipient, in writing, that all terms have been completed. The termination date shall be the date upon which all scheduled events have occurred, including the final accounting, and no further work remains to be completed pursuant to this PFA. The PFA, however, may be terminated earlier for the following reasons:

1 If the Foundation after consultation with the Co-funders and the PAC reasonably determines that the Sub-recipient, or any Subcontractor, is progressing unsatisfactorily, including, but not limited to, failing to comply with this PFA, the Foundation may so Notify the Sub-recipient in writing at any time of the problems/breach and may allow Sub-recipient a chance to cure the problems identified. If the Sub-recipient fails to eliminate problems detailed by the Foundation, or fails to cure a breach of this PFA when and if the Foundation provides a cure period, within thirty (30)

days of the Foundation's Notice, this PFA shall terminate. The termination date shall be the date on which the thirtieth (30th) day falls.

2. Foundation may terminate this PFA without thirty (30) days Notice if the Foundation after consultation with the Co-funders and the PAC reasonably believes the Project is no longer technically feasible or if Sub-recipient failed to comply with the terms and conditions of this PFA. The termination date shall be the date on which the Notice is received. Such termination shall not be considered a breach of this PFA and shall not require a cure period.

3 Co-funders may terminate this PFA on ninety (90) days Notice if Sub-recipient or the Foundation materially breaches this PFA. In such event, an accounting of expended funds shall be submitted by the Sub-recipient promptly after receiving Notice and all unspent non-cancellable funds shall be submitted to the Foundation. The Foundation shall distribute all remaining non-cancellable and unspent funds among the Foundation and Co-funders in proportion to their original funding levels. In the event the Foundation and Co-funders disagree as to whether a Sub-recipient or Subcontractor's actions or omissions are unsatisfactory or a breach of this PFA, the Foundation shall make the final determination. Such determination shall not be considered a breach of this PFA.

4 Upon receipt of the written Notice of termination by Foundation without a right to cure, the Sub-recipient shall cease all work associated with the PFA. If the Foundation issues a Notice of termination with a right to cure, the Sub-recipient shall continue all work, first applying itself to curing the deficiencies noted.

5 The Sub-recipient may terminate this PFA upon thirty (30) days Notice to the Foundation if circumstances beyond its control completely preclude continuation of the research. Notification of termination of research by the Sub-recipient shall be in writing. Sufficient effort will be made by the Sub-recipient to consult with the Foundation's PAC to explore options for continuation of the Project that are acceptable to both parties. An accounting of expended funds shall be submitted by the Sub-recipient and all remaining unspent funds, at the time of Notice, will be returned to the Foundation. The Foundation will return to the Co-funders unspent funds on a pro rata basis in accordance to their contributions.

6. Any change in U.S Federal statutes, rules or regulations or Sub-recipient's local statutes, rules or regulations which materially alter Sub-recipient 's required activity, or any change in the availability of funds shall be viewed as binding and shall warrant good faith renegotiation of the provisions of the PFA that are affected. This change in circumstance includes suspension or termination of this PFA, or a reduction in granted funds. Such alterations or termination shall not be considered a breach of this PFA and shall not require a thirty (30) day advance Notice or cure period.

7 If termination occurs, under this Section XIV, the Sub-recipient shall be entitled to compensation for all satisfactory and authorized services completed as of the termination date, provided funds are available (i.e., a reduction in granted funds per Paragraph XIV.6 above).

8. UPON TERMINATION FOR ANY REASON, THE SUB-RECIPIENT AND CO-FUNDERS SHALL HAVE NO RIGHT TO RECOVER FROM THE FOUNDATION ANY GENERAL,

SPECIAL, INCIDENTAL, CONSEQUENTIAL, OR ANY OTHER DAMAGES OF ANY DESCRIPTION OR AMOUNT, INCLUDING, BUT NOT LIMITED TO ATTORNEYS' FEES AND COSTS. THE TERMS OF THIS PARAGRAPH SHALL SURVIVE THE TERMINATION OF THIS PFA.

**F.** Required Approvals. The individuals executing this PFA on behalf of their respective parties hereby represent and warrant that they have the right, power, legal capacity, and appropriate authority to enter into this PFA on behalf of the entity for which they sign below

**G.** Modifications: This PFA may not be modified or amended, nor may any term or provision be waived or discharged, including this particular Paragraph, except in writing, signed by all parties.

1 Examples of items requiring Foundation's prior written approval include, but are not limited to, the following:

- Deviations from the Project plan.
- Change in scope or objective of the Project.
- Change in a key person specified in the application.
- The absence for more than three months or a 25% reduction in time by the principal investigator
- Need for additional funding.
- Inclusion of costs that require prior approvals as outlined in the appropriate cost principles.
- Any changes in budget line item(s) as described in Exhibit A of greater than ten percent (10%) of the total.

2. No changes are to be implemented by the Sub-recipient until a written Notice of approval is received from Foundation.

**H.** Transferability or Assignment of PFA. This PFA shall not be assignable by the Sub-recipient without the prior written authorization of Foundation.

**I.** Sub-Contracting: Payment for services of any and all Subcontractors shall be the Sub-recipient's sole obligation and responsibility The Sub-recipient hereby indemnifies and holds the Foundation and Co-funders harmless for any liability concerning such payment. In the event Sub-recipient or any Subcontractors are public or quasi-public entities not empowered to indemnify others, Sub-recipient agrees to ensure that the Foundation and Co-funders are not responsible or liable for any such payments or any Subcontractor actions or omissions through appropriate language included in any and all agreements between Sub-recipient and Subcontractors.

**J.** Completeness:

1 This PFA is complete and contains the entire understanding between the parties relating to this PFA.

2. This PFA supersedes all prior understandings, representations, negotiations, and PFAs between the parties whether written or oral.

**K.** Severability: The provisions of this PFA shall be deemed severable, and the invalidity, illegality or unenforceability of any provision of this PFA shall not affect the validity or enforceability of any other provisions. In the event any provision of this PFA is found to be invalid, illegal, or unenforceable, the parties shall endeavor to modify that clause in a manner which gives effect to the intent of the parties in entering into this PFA.

**L.** Foundation Right of Approval. The Foundation and Co-funders shall have the right, in their sole discretion, to refuse to permit any employee of the Sub-recipient, or employee of an approved agent, assignee, or subcontractor of the Sub-recipient, to be located at a Foundation or Co-funders work location, or to provide services to the Foundation, Co-funders or their clientele pursuant to this PFA. Such right of refusal shall not be considered a breach of this PFA.

**M.** Exhibits: All Exhibits attached to or made part of this PFA are incorporated and agreed upon by the parties. In the event a conflict occurs between the terms of an Exhibit and this PFA, the terms of this PFA shall control.

**N.** Federal Compliance: The Sub-recipient shall comply with all applicable Federal, State and local statutes, laws, rules, and regulations in the performance of this PFA, whether included specifically in this PFA or not.

**O.** Foundation and Co-funders Liability: The Foundation and Co-funders shall not have any liability except as specifically provided in this PFA. In no event shall any judgment against the Foundation exceed the amount of funds provided by the Foundation, nor any of the amounts of funds provided by Co-funders to Sub-recipient under this PFA (excluding in-kind grants).

**P.** Notices: Any notice, request, demand, or communication required under this PFA ("Notice") shall be in writing and shall be deemed sufficiently given upon delivery, if delivered by hand (signed receipt obtained), or three (3) days after posting if properly addressed and sent certified mail return receipt requested. These Notices shall become effective on the date of receipt or the date specified within the Notice, whichever comes later Refer to Section III. for key contacts.

**Q.** Captions for Convenience: All captions, fonts, underlining, or footers used in this PFA are for convenience only and shall have no meaning in the interpretation or effect of this PFA.

**R.** Construction: This PFA, and any and all amendments to it, shall not be construed against the drafter

**S.** Force Majeure: None of the parties hereto will be liable for damages for any delay or default in performance during the term hereof if such delay or default is caused by conditions beyond its control, including, but not limited to, acts of God, Government restrictions, continuing domestic or international problems such as wars, threats of terrorism, or insurrections, strikes, fires, floods, work stoppages and embargoes; provided, however, that any party will have the right to terminate this PFA "without breach" upon thirty (30) days prior written Notice if another party's delay or default due to any of the above-mentioned causes continues for a period of two (2) months.

**T.** Security Interest: No party will grant any security interest in, or allow any lien or encumbrance of any nature upon, any Intellectual property in which another party has an interest (i.e., the Foundation Intellectual Property or Jointly Owned Intellectual Property). Breach of this Paragraph may, at the Foundation's or Co-funders' option, require the repayment of all grant monies provided by the

funding party to Sub-recipient under this PFA. The terms of this Paragraph will survive the termination of this PFA.

**U.** Waiver: Waiver of any provision of this PFA must be in writing to be effective. Waiver by the Foundation or Co-funders of any breach of any provision of this PFA on any occasion shall not constitute or operate as a waiver of breach of such provision on any other occasion nor a waiver of any breach of other provisions, nor shall any failure to enforce any provision operate as a waiver of such provision hereof by the Foundation or Co-funders.

**V.** Applicable Law/Venue: This PFA is written and shall be construed in accordance with and governed by the laws of Colorado unless U.S. Federal law applies. However, if legal action is taken against Sub-recipient and U.S. Federal or state laws which exist that govern Sub-recipient (as a quasi public or public entity) exclusively, this PFA shall be construed and interpreted in accordance with such laws. Any action against the Foundation must be brought in a Colorado State Court or U.S. Federal District Court located in Denver, Colorado in the event the mediation/arbitration provisions of this Agreement are modified. The terms of this Paragraph will survive the termination of this PFA.

**W.** Signatures. This PFA may be executed on separate originals or copies and shall be valid as if all parties had executed the same document. Facsimile or electronic signatures shall be valid as written signatures. Foundation will maintain all signed documents for three (3) years after the termination of this PFA and will provide signature pages to all parties upon full execution.

## XV. INDEPENDENT SUB-RECIPIENT

**A.** Relationship.

1 The relationship of all the parties to each other will be that of Independent Contractors and no principal-agent relationship or employer-employee relationship is contemplated or created by the parties to this PFA. Nothing in this PFA shall be construed as creating an agency, partnership, joint venture, or franchise relationship between any the parties. No party shall have any right or authority to assume or create any obligation, commitment or responsibility for or on behalf of the others except as the other may expressly authorize in writing. No party shall be eligible to participate in another's benefit program.

2 Sub-recipient shall be solely responsible for selecting, supervising, and compensating individuals employed pursuant to the terms of this PFA.

3 Sub-recipient shall be exclusively responsible for the payment to its employees and Subcontractors of all wages and salaries, taxes, withholding payments, penalties, fees, fringe benefits, compliance with the wage and hour law, and all other employment laws.

IN WITNESS WHEREOF, the parties have caused this PFA to be signed and dated as shown below

**Water Research Foundation**

By: Robert C. Renner, P.E., D.E.E.
Title: Executive Director

Date: 3/30/2010

**Los Angeles County DPW-Waterworks District**

By: Gail Farber
Title: Director

Date: _____

**Water Research Foundation**

By: Hsiao-Wen Chen
Title: Project Manager

Date: 03-30-2010

Above signed has read and understands the terms, conditions, and deliverables of this PFA.

**Los Angeles County DPW-Waterworks District**

By: T.J Kim
Title: Principal Investigator

Date: _____

Above signed has read and understands the terms, conditions, and deliverables of this PFA.

**Exhibit A**
**Project 04299**

**Title: In-Situ Arsenic Removal on Unsaturated Alluvium**

| Project proposal, & all subsequent correspondence. | Total Number of Pages |
|---|---|
| Proposal | 68 |
| PI's Response to PAC Comments | 6 |
| Communication Plan | 1 |

EXHIBIT A

TC CO-FUNDING SUPPORT FORM

**Note: Each co-funding organization (including the sponsoring utility) must complete a separate Co-Funding Support Form and include it in the proposal.**

Co-Funding Organization: Los Angeles County Department of Public Works - Waterworks (LACDPW - WW)
Type of Organization: _X_water utility __consulting firm __ manufacturer __other (describe)

Is your organization eligible to participate in one of The Foundation's subscription programs?
__X__ Yes ____ No

Is your organization requesting that The Foundation match its funds? __X__ Yes ____No

Is your organization eligible for The Foundation matching funds? __X__ Yes ____No

Cash co-funding amount being provided by your organization (in USD) $ 438,000

Person responsible for contract matters for your organization:
Name: David Pedersen

Address at which FedEx packages can be received: 1000 S. Fremont Ave. Bldg. A9E, Alhambra, CA 91803

Phone/Fax/e-mail: (626) 300-3302 / (626) 300-3385 / dpedersen@dpw.lacounty.gov

Person responsible for accounting matters for your organization:

Name: T.J Kim

Address at which FedEx packages can be received: 1000 S. Fremont Ave. Bldg. A9E, Alhambra, CA 91803

Phone/Fax/e-mail: (626) 300-3327 / (626) 300-3385 / tjkim@dpw.lacounty.gov

What approvals will be required in order for your funds to be released to the Foundation? (e.g., City Council, Board of Commissioners) Los Angeles County Board of Supervisors

Have these approvals been obtained? ____ Yes __X__ No

Can approvals be obtained and co-funding agreements be signed within 120 days of award?
_X____Yes _____No
(**Note:** 120 days after award notification the Foundation may cancel the award--see TC proposal guidelines for details.)

Are there any conditions of the Foundation Co-Funding Agreement that would prevent you from signing it as it is currently worded? _____Yes __X___No
If yes, please explain: (attach additional pages if required)

The person signing below acknowledges they are authorized to commit their organization to the proposed work.

Signature: _____ Print Name: Adam Ariki

Title: Assistant Deputy Director Organization: LACDPW - WW

Date: 4/30/09 Phone: 626-300-3300

Mailing Address: P O Box 1460, Alhambra, CA 91802-1460

## TAILORED COLLABORATION PROPOSAL COVER WORKSHEET

**Proposal Title: In-Situ Arsenic Removal on Unsaturated Alluvium**

**Sponsoring Utility (Foundation Subscriber submitting proposal):** Los Angeles County Department of Public Works – Waterworks (LACDPW · WW)

**Contact at Sponsoring Utility:**
Name: David Pedersen
Address: P O Box 1460, Alhambra, CA 91802-1460
Phone: (626) 300-3302 Fax: (626) 300-3385 e-mail: dpedersen@dpw.lacounty.gov

**Co-Funding and In-kind Summary:** (attach additional sheet if needed)

| Organization Name | Cash Co-fund Amount | In-Kind Contribution Amount (sponsoring utility) |
|---|---|---|
| 1 LACDPW · WW | $438,000 | $95,500 |
| 2 U S Geological Survey | | $135,000 |
| 3. Antelope Valley-East Kern Water Agency (AVEK) | | $180,000 |
| | **Total cash** $438,000 | **In-Kind** $410,500 |

**Project Personnel**
Principal Investigator (i.e , researcher responsible for conducting research)
Name: T.J. Kim
Organization: LACDPW WW
Address: P.O Box 1460, Alhambra, CA 91802-1460
Phone: (626) 300-3327 Fax: (626) 300-3385 e-mail: tjkim@dpw lacounty.gov

Co-Principal Investigator (i.e., researcher responsible for conducting research)
Name: John Izbicki
Organization: U.S. Geological Survey
Address: 4165 Spruance Road, Suite 200, San Diego, CA 92101

Phone: (619) 225-6131 Fax: (619) 225-6101 e-mail: jaizbick@usgs gov

Person responsible for finalizing *Funding Agreement* (i.e., research contract)
Name: David Pedersen
Organization. LACDPW WW
Address: P.O. Box 1460, Alhambra, CA 91802-1460

Phone: (626) 300-3302 Fax: (626) 300-3385 e-mail: dpedersen@dpw.lacounty gov

Person responsible for accounting matters of contractor.
Name: T.J. Kim
Address: P.O. Box 1460, Alhambra, CA 91802-1460

Phone: (626) 300-3327 Fax: (626) 300-3385 e-mail: tjkim@dpw lacounty gov

EXHIBIT A

Foundation Funds Requested: $150,000 USD

Amount of Funds eligible for Foundation match: $303,000 USD

Amount of Funds not eligible for Foundation match: $135,000 USD

Total Cash Budget (Foundation Funds + All Co-Funding Cash): $588,000 USD

Total In-kind Contributions: $410,500 USD

Total Project Budget (Cash + In-kind). $998,500 USD

**Proposals with an incomplete Proposal Cover Worksheet will not be accepted.**

# PROJECT ABSTRACT

## *IN-SITU* ARSENIC REMOVAL ON UNSATURATED ALLUVIUM

**Background:** Arsenic is naturally occurring at concentrations in excess of the Federal drinking water standard of 10 micrograms per liter (µg/L) in about 5 % of water systems in the United States serving about 11 million people. Arsenic removal using alumina or iron oxide resins is the preferred treatment method. This treatment requires significant capital expenditures, can result in the generation of hazardous waste, and has operational costs of about $600 to $800 an acre-foot.

During an artificial recharge experiment along a wash in the Mojave Desert, arsenic in groundwater pumped into a recharge pond was rapidly sorbed as the water infiltrated through the unsaturated zone. This sorption was on naturally occurring alumina, iron, and manganese oxides present on the surfaces of mineral grains. These oxides are similar to those used in commercial resins. Assuming similar sorptive properties and lateral spreading in the unsaturated zone beneath the pond of about 30 to 1, a 300-foot thick unsaturated zone contains enough oxides to lower arsenic concentrations in 100,000 acre-ft of water infiltrated from a one-acre pond from 50 µg/L to less than the drinking water standard of 10 µg/L The infiltrated water would serve as a source of recharge to shallow groundwater where it could be pumped for public supply.

**Objectives:** The purpose of this study is to determine the effectiveness and sustainability of naturally occurring alumina, iron, and manganese oxides in the unsaturated zone to treat high-arsenic water. Results of the study will be used to develop a methodology to transfer the technique to areas having high-arsenic water

**Approach:** The study uses a field-scale experiment in the Antelope Valley groundwater basin of California to demonstrate the treatment technique. Water containing about 50 µg/L arsenic will be pumped from deeper aquifers and infiltrated into a pond. Arsenic in the infiltrated water is expected to be sorbed on naturally occurring alumina and iron oxides and the water will recharge the shallow aquifer having arsenic concentrations of about 1 µg/L. The movement of water and effectiveness of naturally occurring alumina, iron, and manganese oxides in the unsaturated zone to sorb arsenic will be monitored using data from an instrumented borehole installed at the site. Arsenic concentrations and toxicity of unsaturated materials will be determined before and after the infiltration as part of this study. Laboratory column experiments will be done on samples of unsaturated alluvium to evaluate the physical and chemical factors that control sorption of arsenic under different geochemical conditions. Batch experiments will be done using radiolabled arsenic-73 to determine the long-term fate of sorbed arsenic and its potential mobility.

**Anticipated Results:** The project will demonstrate the effectiveness of *in-situ* remediation of arsenic and will treat an estimated 3,200 acre-feet of groundwater having high-arsenic concentrations. Pond maintenance costs are expected to be minimal and limited to occasional removal of fines from the pond bottom If the study is successful, it will be possible to treat 100,000 acre-feet of water at a cost of approximately $150 per acre-foot in 2008 dollars resulting in a cost savings of $45 to $65 million dollars over the life of the site compared to arsenic removal using sorption on commercially available resins. The approach is expected to be highly transferrable. Results of the study will include a methodology to transfer the approach to other areas having high-arsenic water.

**Sponsoring Utility, Principle Investigator, and Contractor:** The sponsoring utility for this research will be the Los Angeles County Department of Public Works □ Waterworks (LACDPW □ WW). The principal investigator (PI) will be T.J. Kim, Ph.D., P.E., of LACDPW □ WW and co-PI will be John Izbicki, Ph.D., of U.S. Geological Survey (USGS). The work will primarily be performed by U.S. Geological Survey personnel under a contract with LACDPW □ WW.

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EXHIBIT A

# PROJECT DESCRIPTION

## Background

Arsenic is a common element in rocks that compose the earth's crust (Hem, 1970) and is often strongly associated with iron minerals. Arsenic exists at low concentrations in many hydrogeologic settings and can occur naturally at concentrations high enough to be detrimental to human health Arsenic compounds have been widely used as medicines, herbicides, poultry feed supplements, and in a wide range of industrial applications Although arsenic exists in nature in the -3, 0, +3, and +5 valence states, only arsenic (III) and arsenic (V) (As III and As V, respectively) are significant in aqueous solutions (Rai and Zachara, 1984) As III is the stable form of arsenic in reduced (oxygen absent) water, and As V is the stable form in oxygenated water As III and As V may co-occur in water because conversion of As III to As V, or As V to As III, is a slow reaction (Welch and others, 1988). Although As III is more toxic than As V, both As III and As V are toxic and the Maximum Contaminant Level (MCL) is for total arsenic (As III plus As V)

Arsenic in water has long been a source of concern because of toxic and carcinogenic effects In January 2001, the U S Environmental Protection Agency (EPA) reduced the MCL for arsenic in drinking water from 50 to 10 micrograms per liter (µg/L) This reduction was in response to recent information on the risk of lung and bladder cancers (Morales et al., 2000). The new MCL became effective January 2006 Arsenic is naturally occurring in some sources of water supply at concentrations in excess of 10 µg/L. Tiemann (2001) estimated that about 5 % of water systems in the United States serving about 11 million people were likely to exceed the new MCL Arsenic in excess of the MCL is expected more frequently in groundwater supplies than in surface-water supplies, and is of particular concern in parts of New England, the interior plains, and the western United States (Focazio, et al., 1999; Federal Register, 2001, Welch et al , 2000; Ryker, 2001)

Arsenic removal technologies investigated by the U S EPA prior to implementation of the new MCL focused of sorption of arsenic on activated alumina or iron resins (Chen and others, 2004) Although inexpensive compared to other available arsenic removal technologies, such as coprecipitation with iron, arsenic removal using sorptive resine requires significant capital expenditure, and operational costs including possible disposal of the used resin as a hazardous waste (Chen and others, 2004) A number of simple inexpensive arsenic removal systems have been developed for use in rural areas of developing countries (Khan, and others, 2000; Cornejo and others, 2008; Di and Monnell, 2009) These systems rely on locally available materials and some of these systems take advantage of the fact that alumina and iron oxides are naturally occurring and abundant. However, these approaches are limited to the size and scope of water supplies typical for rural areas in developing countries

Sorption of arsenic on naturally occurring alumina and iron oxides coatings on mineral grains in the unsaturated zone was observed during groundwater recharge (Izbicki and others, 2008) Sorption occurred at rates sufficient for arsenic removal in municipal supplies. Alumina and iron oxide coatings are ubiquitous on mineral gains in soils and

alluvial deposits. Their occurrence is largely a function of surface area associated with fine-grained deposits. Results of work by Izbicki and others (2008) suggested that thick unsaturated zones having abundant alumina and iron oxides associated with paleosol development would be a favorable setting for *in-situ* arsenic removal during infiltration through the unsaturated zone. These settings have been widely overlooked for artificial recharge because of their lower permeability compared to coarser-grained alluvial deposits. Although the *in-situ* removal of arsenic was demonstrated, the physical and chemical factors that control sorption were not thoroughly investigated by Izbicki and others (2008). These factors need to be understood at the field and laboratory scale to establish guidelines, methodologies, and regulatory approval to implement *in-situ* remediation before the approach will have wide-spread transfer value to other areas.

The USGS and LACDPW-WW have been in communication with the Lahontan Regional Water Quality Control Board (RWQCB) in order to achieve regulatory approval. The RWQCB is very pleased with the proposal and have given much positive feedback along with their comments and suggestions. They would like to see monitoring of additional constituents to receive long-term regulatory acceptance as well as the necessary permits and regulatory documents for the implementation of a pilot scale project to prove this technique can be widely used and accepted. LACDPW-WW will comply with the RWQCB's comments and is in the process of putting together the necessary documents. LACDPW-WW and Lahontan RWQCB have agreed that LACDPW-WW will meet all of the requirements of a full scale project and plans to submit draft applications for a Waste Discharge Permit in September 2009 and CEQA documentation in October 2009 in order to complete the process by the end of 2009.

The Antelope Valley in the western Mojave Desert of southern California was selected for the demonstration of *in-situ* remediation of arsenic at the field scale during infiltration through the unsaturated zone. As part of this proposal, alluvial materials from the site will be used for laboratory experiments designed to describe the physical and chemical factors that control arsenic sorption. Groundwater has been, and continues to be, an important resource for a half million people in the Antelope Valley. Prior to 1972, groundwater provided more than 90 percent of the total water supply in the Antelope Valley; since 1972, it has provided between 50 and 90 percent. Projected urban growth and limits on the available imported water supply are likely to continue to increase the reliance on groundwater. The Antelope Valley consists of 10 mutual water companies and 7 wholesale/retail water agencies.

## Description of the Study Area

The Antelope Valley ground-water basin in the western Mojave Desert near Lancaster, California covers about 930 square miles and is filled with alluvial and lacustrine deposits that are as much as 5,000 feet thick (Brenda et al., 1960; Mabey, 1960; Londquist et al., 1993). The alluvial deposits consist of interbedded heterogeneous mixtures of fine-grained silt, coarse-grained sand, and gravel, and the lacustrine deposits primarily consist of thick layers of blue-green clay and brown clay (Dutcher and Worts, 1963; Bloyd, 1967, Durbin, 1978). Stratigraphic, hydrologic, and water-chemistry data were used to divide the water-bearing deposits in the Antelope Valley into three aquifers: the upper, middle, and lower (Leighton and Phillips, 2003). In the Lancaster area, the upper and middle aquifers consist of alluvial fan deposits from the San Gabriel Mountains that are predominantly granitic in origin. A 200-foot thick lacustrine clay

separates the middle and lower aquifers in the Lancaster area (Figure 1); however, these clay deposits are not present in the study area. The lower aquifer consists of older sedimentary deposits that include detritus of tertiary-volcanic rocks (Leighton and Phillips, 2003) The upper aquifer is unconfined to partly confined and the middle and lower aquifers are confined.

Arsenic concentrations in the lower aquifer can exceed the MCL for arsenic as a result of reduced conditions. Some wells that yield water from the lower aquifer have water with arsenic concentrations as high as 78 µg/L. In contrast, the upper and middle aquifers are oxic and have arsenic present in low concentrations, commonly near 1 µg/L. In 21 LACDPW WW wells sampled by the U S. Geological Survey (USGS), almost all the arsenic was in the form of As V with only one well having significant As III concentrations of about half the total dissolved arsenic. Similarly, As III was present at concentrations above the detection limit of 0.2 µg/L in only 16 percent of wells sampled throughout the western Mojave Desert, including Antelope Valley, with water from only one well having an As III concentration greater than As V (Izbicki and others, 2008b) Tests performed by the LACDPW · WW showed similar results with As V concentrations averaging 22 5 times greater than As III Many wells in the area are completed in the upper, middle, and lower aquifers and water from these wells is a mixture of water from these aquifers. Recent USGS work demonstrated the effectiveness of well modification to lower arsenic concentrations in wells screened in the upper, middle, and lower aquifers by sealing the lower portion of those wells that yield high-arsenic water (Stamos and others, written communication, 2008)

As a result of the new MCL for arsenic of 10 µg/L, which became effective January 2006, water from the lower aquifer is no longer suitable as a source of public supply without treatment or blending. This loss of supply from the lower aquifer and subsequent increased pumping from the upper and middle aquifers has occurred while the area is undergoing adjudication as a result of pumping in excess of recharge resulting in declining water levels In addition, replacement water from the California Aqueduct is less available due to endangered species management issues within the San Joaquin Delta along with the increased demand for water as a result of continued population growth

The proposed treatment site is in the northwestern part of the Lancaster subbasin, north of the Antelope Buttes, approximately 16 miles northwest of Lancaster, California (Figure 1) The site encompasses about 1,500 acres and is owned by Antelope Valley East Kern Water Agency (AVEK). Approximately one acre of the land will be used for this work. Historically, the site has been used for agricultural purposes, primarily row crops and alfalfa In 2008, the water table was about 250 feet below land surface (bls) in the eastern part of the project area. The unsaturated alluvial deposits at the site consist of interbedded heterogeneous mixtures of silt, sand, and gravel Given the depositional environment, unsaturated alluvium is expected to contain paleosols having sufficient alumina, iron, and manganese oxide development to sorb arsenic in water infiltrated from ponds. Due to the thick unsaturated zone and low-permeability paleosols, it may take as long as two years for the infiltrated water to reach the water table.

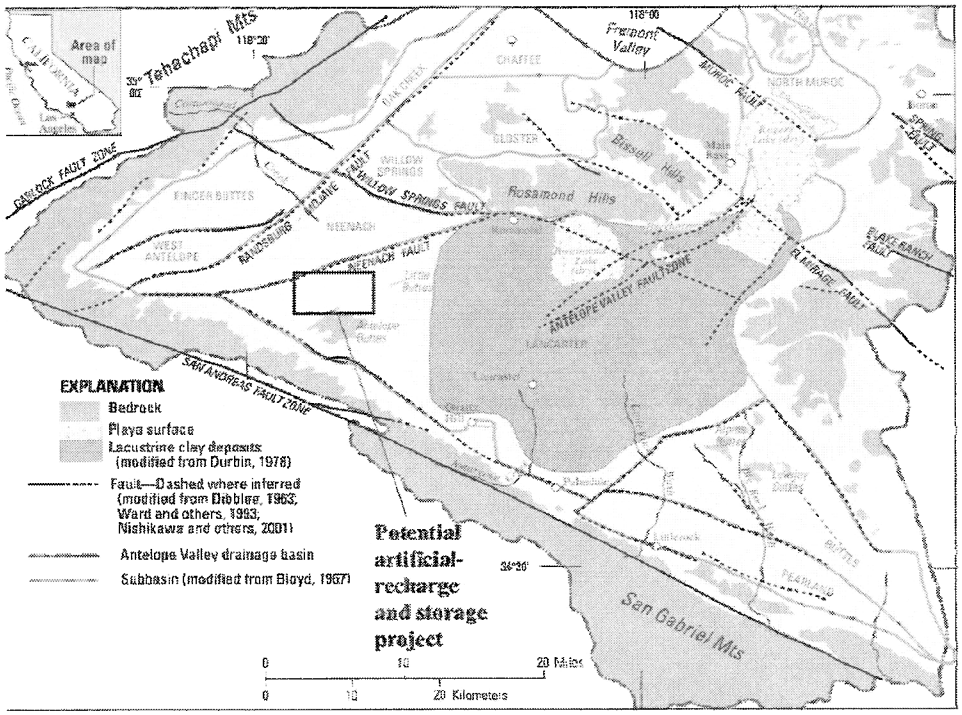


Figure 1.—Study area location

Sorption of Arsenic in the Unsaturated Zone

Sorption of arsenic on alumina, iron, and manganese oxides is the basis of commercial resin technology used to remove arsenic from groundwater (Chen and others, 2004) These oxides are ubiquitous and naturally occurring on the surfaces of mineral grains (Figure 2)

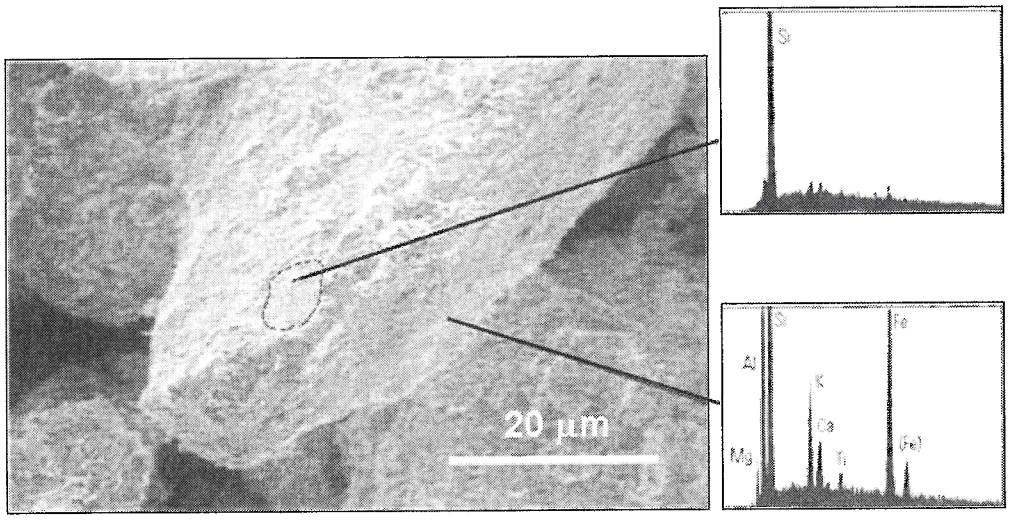


Figure 2.—Scanning electron photomicrograph of alumina and iron oxide coatings on a quartz mineral grain (Modified from Izbicki and others, 2003)

Factors such as oxidation state, pH, and the presence of competing ions can effect the sorption of arsenic. As III and As V have different absorption characteristics because of their valences (Rai and Zachara, 1984). In general As V is more strongly sorbed than As III. Maximum sorption of As III occurs between pH 7 and 9, while sorption of As V is highest at low pH and decreases at pHs between pH 7 and 9 (Rai and Zachara, 1984). Typical pH values in LACDPW - WW wells range from 6.5 to 8.5, and are within the U.S. EPA range for optimal arsenic sorption. Phosphate competes with arsenic for sorption sites and the presence of natural organic matter decreases sorption. Phosphate is present only at low concentrations in LACDPW WW wells, and alluvium in desert areas typically contains only small amounts of organic material. Other ions, especially oxianions, such as chromium or vanadium, are not expected to be present at high enough concentrations to compete with arsenic for sorption sites.

Sorption of arsenic to alluvial deposits has been observed in unsaturated alluvium at an artificial recharge site along Oro Grande Wash near Victorville west of the Antelope Valley (Izbicki and others, 2008b), and to soils at other sites (McGeehan and others, 1998; Gimenez and others, 2007, Kniewald and Fiket, 2007). These studies have shown sorption to occur within days under oxic, alkaline conditions and that naturally occurring alumina, iron, and manganese oxides have similar sorptive properties as synthetic sorbents.

During artificial recharge along Oro Grande Wash, arsenic in groundwater pumped into a test recharge pond was rapidly sorbed as water infiltrated through the thick unsaturated zone to the water table (Figure 3) (Izbicki and others, 2008a). Arsenic concentrations in recharged water declined from their initial concentration of 10µg/L to less than 1 µg/L within 20 feet of the pond bottom (Figure 3). Concentrations at this depth remained

below the MCL for arsenic during the entire study but showed small increases after two years of infiltration. At deeper depths, closer to the water table, arsenic concentration declined to less than 1μg/L after the arrival of water infiltrated from the pond and remained at that concentration during the entire study (Figure 3). The unsaturated zone underlying the Oro Grande recharge pond had numerous buried soil horizons (paleosols) These paleosols increased the available surface area, and the abundance of oxides on mineral grains, thereby increasing the potential for sorption of arsenic compared to coarser-grained materials Although the Oro Grande site was less desirable for groundwater recharge than coarser-grained, highly-permeable sites along major streams and rivers that have less paleosol development—once wetted, water was able to infiltrate through the unsaturated zone at the Oro Grande location to the underlying water-table aquifer in about one year (Izbicki and others, 2008)

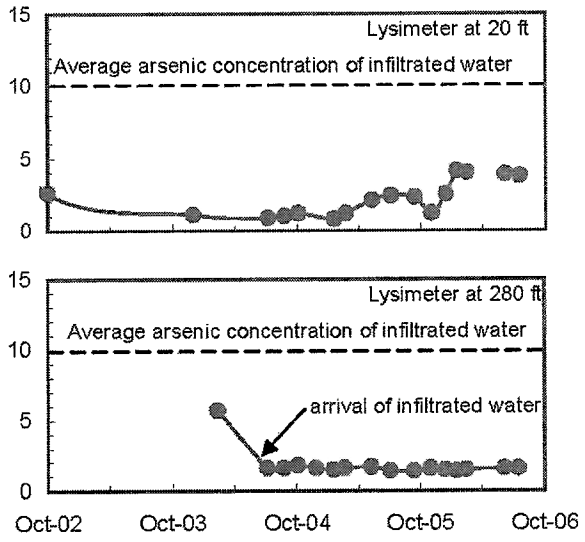


Figure 3 —Arsenic concentrations in selected suction-cup lysimeters beneath a recharge pond near Oro Grande Wash, Victorville, Calif., (Modified from Izbicki and others, 2008)

During the Oro Grande experiment, the upper 20 feet of unsaturated material underlying the pond lowered arsenic concentrations in 1,050 acre-feet of water infiltrated at the site from 10 μg/L to less than 1 μg/L As water from the Oro Grande recharge pond infiltrated to greater depths, the amount of lateral spreading from the pond increased The one-acre pond had an average wetted footprint in the unsaturated zone of about 30 acres (Izbicki and others, 2008a). Assuming similar sorptive capacity and a similar amount of lateral spreading within the unsaturated zone beneath Antelope Valley, the total volume of unsaturated material encountered by water infiltrated from a one-acre pond could treat 100,000 acre-feet of water Assuming an average infiltration rate of 2 feet/day through the bottom of the pond, 450 gallons/minute of water could be treated using this approach for more than 100 years before the sorptive capacity of a 300-foot thick unsaturated zone would be exhausted

Neglecting the substantial investment in equipment and engineering design, the cost of arsenic treatment using commercially available sorptive media is between $600 and $800 dollars an acre-foot (LACDPW □ WW, T.J Kim, oral commun., 2008) The cost of treating water to remove arsenic using the proposed *in-situ* approach is essentially the cost of pumping the water twice. The pumping cost in Antelope Valley in 2008 was about $150 per acre-foot. These data suggest that *in-situ* arsenic removal will result in a cost savings of $45 to $65 million over the life of the site compared to removal using commercially available sorptive media.

Data from the Oro Grande recharge site (Izbicki and others, 2008a) suggests that the arsenic concentration in the solid phase in the upper 20 feet of the unsaturated zone increased two orders of magnitude from about 0.09 mg/kg (typical values for granitic alluvium) to about 9 mg/kg as a result of sorption of arsenic during recharge This higher value is still four orders of magnitude less than arsenic concentrations of spent commercial sorptive media used to remove arsenic from groundwater Spent sorptive media commonly contains sufficient arsenic to require disposal as a hazardous waste However, alluvium beneath the pond will not qualify as hazardous waste because the toxicity testing is done on a total weight basis and the bulk of the unsaturated alluvium is composed of inert silicate minerals that do not contain arsenic.

## Objectives

The purpose of this study is to determine the effectiveness and sustainability of naturally occurring alumina, iron, and manganese oxides in the unsaturated zone to treat high-arsenic water A field-scale experiment in the Antelope Valley groundwater basin of California will be used to demonstrate the technique, and laboratory data will be used to evaluate the physical and chemical properties that control arsenic sorption. The combination of field and laboratory work will be used to develop a methodology to transfer the approach to others areas having high-arsenic water and suitable geology

## Approach

Water containing about 50 mg/L arsenic will be pumped from a well on the proposed site that is perforated opposite the lower aquifer and infiltrated into a pond. Water infiltrated from the pond will recharge the upper aquifer at the site that contains low concentrations of arsenic. The effectiveness of naturally occurring alumina, iron, and manganese oxides in the unsaturated zone to sorb arsenic will be evaluated on the basis of arsenic concentration data from suction-cup lysimeters installed in an instrumented borehole adjacent to the pond In addition, matric potential will be monitored as water infiltrates to the water table to determine the downward rate of water movement and the extent of lateral spreading of infiltrated water Arsenic concentrations and toxicity characterization of unsaturated materials will be determined as part of this work. Laboratory studies will be done to determine physical and chemical properties of alluvium that control arsenic sorption and the long-term fate and potential release of arsenic sorbed to unsaturated alluvium. In preliminary discussions with the Lahontan Regional Water Quality Control Board (RWQCB) they have agreed to consider a waiver of permits for this project.

Task 1. Installation of an Instrumented Borehole

An instrumented borehole will be installed in the unsaturated zone adjacent to the proposed pond location. The borehole will be drilled using the ODEX (Overburden Drilling EXploration) method. This drilling method uses air rather than water as a drilling fluid, because water would contaminate unsaturated deposits altering their matric potential and fluid chemistry. The drill hole will be stabilized by an 8 7/8-inch diameter steel pipe that is advanced into the hole behind the drill bit. Drill samples will be collected at one-foot intervals and lithology will be recorded by field personnel. A slurry of sieved cutting material and deionized water will be analyzed in the field on each one-foot of cutting material for specific conductance as a measure of soluble salts. Core material will be collected at selected intervals using a piston core barrel. Core samples will be protected against evaporation and preserved with heat-sealable material using methods described by Hammermeister and others (1986) and Izbicki and others (2000). Natural gamma and neutron logs will be collected from the ODEX drill hole after drilling is completed. The natural gamma log provides a measure of clay abundance and the neutron log provides a measure of the relative water content of the unsaturated deposits.

The borehole will be equipped with a two-inch diameter PVC water table well, three advanced tensiometers, eight heat dissipation probes, and 10 suction cup lysimeters (fig. 4). Depth of instrument placement will be determined from lithologic and chemical data and geophysical logs collected during drilling. The water table well will provide a measuring point for water level and water quality data collection and will serve as an access tube for geophysical instruments. Advanced tensiometers determine matric potential within the tensiomenter range (about -800 cm) and, if saturated, pressure up to about 800 cm. Advanced tensiometers are commonly installed above clay layers or other materials where saturated conditions are expected to develop during recharge. Advanced tensiometers are connected to the surface through a one-inch diameter PVC pipe and only a limited number can be installed in a borehole. The heat dissipation probes measure matric potentials drier than the tensiometer range from -7 cm to -10,000 cm. Heat dissipation probes, which are commonly installed in thick, coarse-grained layers or beneath clay layers, are connected to the surface through wires. The number of heat dissipation probes installed in a borehole is usually limited to the number of available channels on the data logger, usually eight. Suction cup lysimeters extract water from saturated material and unsaturated material having matric potentials less negative than about -60 cm. The wetter the material, the more water will be extracted by the lysimeter. The suction cup lysimeters are connected to the surface using two, 1/8-inch diameter tubes, one for vacuum and pressurization of the lysimeter and the other for sample collection.

Each instrument will be installed in a specialized material that is intended to facilitate equilibrium between the instrument and the matric potential of the unsaturated deposits. These materials include #60 graded sand for advanced tensiometers, and silica flour for heat-dissipation probes, dielectric permittivity sensors, and suction-cup lysimeters. The materials have been tested in previous studies and have been shown to not contaminate water samples for selected trace elements such as chromium or arsenic. Additional testing will be done as part of this study to ensure borehole materials do not contaminate unsaturated zone water with arsenic. The borehole will be sealed between instruments using a low-permeability bentonite grout to ensure the borehole will not be a conduit for the downward flow of water. Frequent sounding are required to ensure backfill material is properly placed with respect to instruments in the borehole and to ensure the integrity

of features, such as low-permeability clay layers that may impede the downward movement of infiltrating water After site completion, an electromagnetic (EM) log will be collected from the PVC well to insure instruments were properly placed within the borehole. The EM log as will serve as a baseline to evaluate changes in electromagnetic resistivity of unsaturated materials caused by infiltrating water during the experiment.

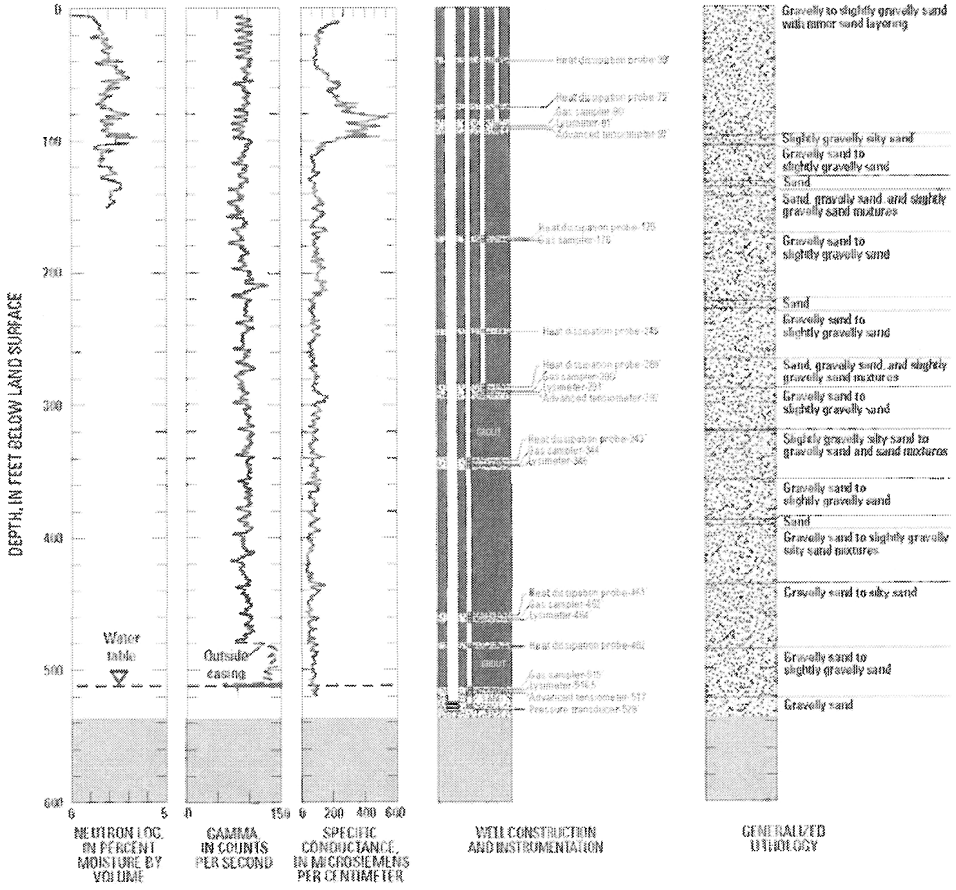


Figure 4.—Design of a typical unsaturated zone monitoring site.

Task 2: Determination of physical and chemical properties of unsaturated materials

Physical and chemical properties of unsaturated material collected during drilling will be measured at USGS laboratories in Sacramento, California (physical properties), San Diego, California (soluble anions), and Denver, Colorado (trace elements) Analysis of material from the borehole will be needed to refine estimates of the performance of the in-situ removal of arsenic.

Physical Properties. Physical properties, such as water content, matric potential, saturated hydraulic conductivity, and unsaturated hydraulic conductivity will be determined using standard ASTM procedures on core material preserved in the field to prevent moisture loss Water content will be measured gravimentrically on a weight basis Gravimetric water content will be converted to volumetric water content on the basis of sample bulk density measure on the same material. Matric potential will be

measured using the filter paper method. Calibrated filter papers will be inserted into the top and bottom of core liners in the field at the time of collection as part of the preservation process.

Particle-size data can be measured on ODEX drill cuttings and will be determined more frequently than other physical properties. These data provide an opportunity to extend more expensive analytical data from less-frequently collected core material to other depths within the unsaturated zone. In addition to physical properties the organic carbon content of selected samples alos will be measured

Soluble Anions. Water extractions will be done to extract soluble salts from unsaturated material collected from the borehole Water extractions will be prepared on a one to one, weight per weight basis, with drill cutting and deionized water Extractions will be shaken on a wrist shaker for 24 hours, allowed to stand, or if necessary centrifuged, to allow particulates to settle, and filtered prior to analysis for pH and by ion-chromotography for chloride, nitrate, fluoride, phosphate, and sulfate Results will be expressed as micrograms per gram of alluvium Chloride provides a measure of natural recharge through the unsaturated zone or if no recharge is occurring the length of time since recharge last occurred. Soluble anions accumulated in the unsaturated also may alter the quality of infiltrating water as it first passes through the unsaturated zone to the water table.

Trace Elements: Acid extractions will be done using methods described by Chao and Sanzalone (1989) and modified by Izbicki and others (2008b) to extract metals sorbed on mineral grains in the unsaturated zone. Although operationally defined, the extractions are believed to be sufficiently vigorous to remove the oxide coatings on mineral grains without digesting (dissolving) the mineral grains. Extractions will be analyzed for arsenic, chromium, vanadium, uranium, aluminum, iron and manganese using ICP-MS Results will be expressed in micrograms per gram of alluvium. Acid-extract data from different depths will be normalized for the availability of exchange sites on the basis of aluminum, iron, and manganese data. These results will be compared with data normalized for surface area on the basis of concurrent particle-size data.

Acid-extract data will be used to compare arsenic abundance with data from other sites in the Mojave Desert. These data also will be used as a baseline to evaluate the sorption and distribution of arsenic and other trace elements in the unsaturated zone after water has reached the water table. The data also will be used to refine estimates of oxide abundance and sorptive capacity and to determine the projected life of the *in-situ* arsenic removal project.

Toxicity characteristic leaching procedure (TCLP), Method 1311 (U S Environmental Protection Agency, 1992), will be done on selected cuttings to determine the amount of arsenic and other selected trace elements that may be mobilized from the material This test is used to determine if a material qualifies as a hazardous waste Alumina and iron oxides used in commercially available media to remove arsenic from groundwater have a high surface area, and consequently a high sorptive capacity, per unit weight When spent these media commonly exceed TCLP values and are considered hazardous. Sorption of arsenic on alumina and iron oxides on mineral grains is unlikely to create a hazardous waste because TCLP values are on a per weight basis and most of the mineral grain is inert silicates.

Task 3. Laboratory Studies of Arsenic Sorption

Column experiments will be done on samples of unsaturated alluvium collected during test drilling to determine sorptive properties of three representative materials selected on the basis of texture and paleosol development Materials will be obtained during drilling and are expected to range from sandy-textured alluvium, to silty alluvium, to pedogenically-altered alluvium. The experiments will be done at the U S Soli Salinity Laboratory in Riverside, Calif Results of laboratory experiments will be used to interpret field-scale experiment and to develop a methodology to transfer results to other areas.

To obtain sufficient material for the column studies, selected samples from different depths will be aggregated, sieved to remove gravels, and homogenized using a soil splitter For each sample material, column experiments will be done under alkaline, oxic conditions using water that has chemistry similar to water that will be infiltrated at the site The experiments will be done at two pH□s and at two As V concentrations Experimental water at pH levels between slightly alkaline (7 5) to highly alkaline (8.5) and at As V concentrations between 10 to 100 μg/L will be used Alkaline pH□s, exceeding 7.5 and as high as 10, are typical for unsaturated zone water in arid areas. Three replicate columns will be run for each textural type, pH, and arsenic concentration for a total of 36, one-foot long by two-inch diameter, columns. Depending on the permeability of alluvial materials column length may need to be adjusted to ensure adequate contact between infiltrating water and column material An additional set of three columns will be prepared to evaluate sorption of As III for one textural type, at one pH, and at one As V concentration Aggregation and homogenization of material from different depths is necessary to obtain a sufficiently large volume of material having uniform properties for analysis.

Prior to the experiment, selected physical and chemical properties of the aggregated and homogenized sample material will be determined including: particle size, surface area, organic carbon content, and extractable metals (iron, manganese, and arsenic) Extractable metal concentrations will be determined using a sequential procedure designed to evaluate operationally defined sorption sites on the alluvium In addition, TCLP analysis of aggregated material will be done to determine the materials potential for toxicity with respect to arsenic. Hazardous concentrations of arsenic are not expected to be encountered in native material or produced as part of this experiment.

Water having major-ion concentrations similar to native water (Table 1) will be prepared in the laboratory and infiltrated through the columns. Laboratory prepared water will be used rather than native water from the site to avoid unforeseen sorptive, reductive or other interferences in the experiments Approximately 50 pore-volumes of laboratory water, which will depend on the timing of the arsenic breakthrough from the column, will be passed through the columns. Flow through the columns will be continuous and discrete pore-volumes will be analyzed for pH, specific conductance, and arsenic concentrations to characterize the arsenic breakthrough from the column and to determine the sorptive capacity of the material. After the experiment, material in the column will be harvested and analyzed for sequentially extractable metals and TCLP to determine where in the column. and within which operational fraction defined by the sequential extraction procedure, the arsenic has sorbed Results of the experiment will be interpreted using the computer program UnsatChem to develop predictive relations between the measured physical and chemical characteristics of the alluvium and arsenic sorption

Table 1.—Expected chemistry of water to be recharged at the treatment site.

[Data from analysis of water from well RG-5 by Antelope Valley East Kern Water District June 14, 2007. ND, not detected.]

| | | |
|---|---|---|
| pH | | 7.9 |
| Specific conductance | microSiemens per centimeter | 430 |
| Residue on Evaporation | milligrams per liter | 290 |
| Calcium | milligrams per liter | 42 |
| Magnesium | milligrams per liter | 4.6 |
| Sodium | milligrams per liter | 49 |
| Alkalinity | milligrams per liter as CaCO3 | 143 |
| Sulfate | milligrams per liter | 28 |
| Chloride | milligrams per liter | 50 |
| Nitrate | milligrams per liter as NO3 | 13 |
| Nitrite | milligrams per liter as N | ND |
| Fluoride | milligrams per liter | 0.37 |

Trace Elements

| | | |
|---|---|---|
| Aluminum | micrograms per liter | ND |
| Antimony | micrograms per liter | ND |
| Arsenic | micrograms per liter | 29 |
| Barium | micrograms per liter | 17 |
| Beryllium | micrograms per liter | ND |
| Boron | milligrams per liter | 0.6 |
| Cadmium | micrograms per liter | ND |
| Chromium (Cr III + Cr VI) | micrograms per liter | 3.2 |
| Chromium VI | micrograms per liter | 2.8 |
| Copper | micrograms per liter | ND |
| Iron | micrograms per liter | ND |
| Lead | micrograms per liter | ND |
| Manganese | micrograms per liter | ND |
| Mercury | micrograms per liter | ND |
| Nickel | micrograms per liter | ND |
| Selenium | micrograms per liter | ND |
| Silver | micrograms per liter | ND |
| Thallium | micrograms per liter | ND |
| Vanadium | micrograms per liter | ND |

Note: There were no detections of organic compounds in water from well RG-5.

A series of desorption experiments will be done to determine the mobility of As V sorbed on the experimental columns at different pHs and water compositions. The experiments will be designed in consultation with the RWQCB to meet regulatory needs and will be done shortly after the completion of the initial sorption experiment using water having a low-arsenic concentration but otherwise similar in composition to the experimental water used in the column studies Additional desorption experiments may be required using

water having a range of pH and dissolved organic carbon concentrations to determine the long-term mobility or immobility of arsenic sorbed on alluvial deposits. These additional experiments are beyond the scope of this proposal.Prior to final approval of the project for long-term use, the Lahontan RWQCB has indicated that studies addressing the long-term effects on arsenic sorbed in the unsaturated zone will be required. The primary concern is whether or not sorbed arsenic will become mobile under changing hydrologic conditions in the future or will the arsenic become increasingly mineralized and less mobile with time It is not possible to address changes in arsenic mobility resulting from incorporation of sorbed arsenic into mineral phases through time using the traditional column experiments described previously

To address this issue, batch experiments will be done on homogenized sample material slurried with sample water amended with arsenic-73 at known concentrations. Arsenic-73 is a radioactive isotope of arsenic having a half life of approximately 80 days Initial arsenic-73 activities in the batch experiments will be sufficiently large to ensure measurable radiation in the slurries for as long as one year The slurries will be incubated under oxic conditions typical of unsaturated zones and at temperatures and pHs expected in the unsaturated zone Material from the batch experiments will be harvested at selected intervals and samples analyzed to determine if the arsenic concentrations on operationally defined sorption sites change with time Arsenic-73 is used for this purpose rather than tradition chemical measurements because small changes in arsenic-73 partitioning within the solid phase can be easily and directly measured on the basis of radioactivity. These data will be used to determine if the sorbed arsenic has become increasingly mineralized and therefore less mobile with time, or if arsenic remains sorbed on minerals grains and highly mobile given changing geochemical conditions in the unsaturated zone Batch experiments are more suitable for this type of experiment than column experiments because of the smaller volumes of water requiring less radioactive arsenic-73 needed for the experiment. Results of these studies will be used to determine if land use controls may be needed to prevent future mobilization of arsenic beneath recharge ponds.

Task 4. Data collection from the Instrumented Borehole

Monitoring of the infiltration and movement of applied high-arsenic water through the unsaturated zone will be done using a combination of data collected from the instrumented borehole installed in Task 1 Data collection at the site will begin prior to the onset of infiltration from the pond, during infiltration from the pond, and continue until infiltrated water reaches the water table The pond will be about one acre in size with an assumed pond depth of about two feet. The infiltration rate is expected to be about two feet per day with a residence time in the pond of about one day The chemistry of source water to the pond and water within the pond will be monitored during this study for constituents listed in Table 2 Expected composition of the source water is given in Table 1 Although almost all the sorption of arsenic is expected to occur in the unsaturated zone, algae grown within the pond will be sampled to determine if it accumulates arsenic.

Initially, water is expected to take about two years to reach the water table 300 feet below land surface The downward rate of water movement is a function the hydraulic properties of the unsaturated material and the volume of water infiltrated from the pond. The more water applied and infiltrated from the pond, the more rapidly the unsaturated zone beneath the pond will be wetted Once the unsaturated zone has been wetted by

infiltrating water, the downward rate of movement of infiltrating water will increase, possibly reaching the water table in about one year

Data from advanced tensiometers and heat dissipation probes will be collected at four-hour intervals from the surface using data loggers installed in a vault at land surface shortly after completion of the borehole. The data logger can be operated either on batteries, batteries supplemented with solar power, or, preferably from power at the site. Equilibration of instruments and surrounding backfill will be monitored to ensure instrument performance, determine when the borehole has equilibrated with the surrounding unsaturated zone, and provide background data prior to the infiltration of water at the site.

After the backfill has equilibrated with the unsaturated zone and grout has hydrated an EM log will be collected This log will serve as a baseline to evaluate changes in water content in the unsaturated zone between instruments after water has been infiltrated from the pond. After water is applied to the pond, EM logs will be collected about every other month to monitor the downward migration of the applied water

Samples will be collected from the lysimeters at six-week intervals when the lysimeters are serviced. Initial matric potentials are expected to be more negative than -60 cm and lysimeters are not expected to produce water prior to the infiltration of water Water from the lysimeters will be analyzed for field parameters (pH and specific conductance only), selected anions (including chloride, nitrate, and sulfate), selected trace elements (including arsenic, chromium, vanadium, and uranium), and the stable isotopes of oxygen and hydrogen (Table 2) Frequently, lysimeters do not produce sufficient water for all constituents to be analyzed Assuming sufficient volume for analysis, two samples from the lysimeters, which will ideally be collected shortly after the lysimeter begins to produce water and near the end of the study, will be analyzed for the more complete suite of constituents measured from the well

The water table well installed at the site will be sampled prior to the application of water to the pond and after the applied water has reached the water table Water from the well will be analyzed for field parameters (pH, specific conductance, temperature, and dissolved oxygen) major ions, nutrients, selected trace elements (including arsenic, chromium, vanadium, and uranium) and the stable isotopes of oxygen and hydrogen (Table 2) The redox species of arsenic and chromium will also be determined. In addition to the water table well, nearby agricultural supply wells will be sampled and analyzed as part of this study, The analyses of water from the monitoring well and selected nearby production wells are needed to evaluate expected water chemistry changes in the upper aquifer prior to the infiltration of water from the proposed test pond to the shallow aquifer

## Table 2.—Major-ion, selected trace-element, and nutrient data to be analyzed as part of this study

[USGS parameter code assigned for identification and data storage purposes in USGS National Water Information System (NWIS). CAS number. Chemical Abstract Services number assigned by the American Chemical Society for identification and computer search purposes. --, CAS number not assigned. Laboratory reporting level (LRL) is in milligrams per liter (mg/L), micrograms per liter (µg/L), microSiemens per centimeter (µS/cm), or standard units for pH. Lower values may be reported as estimated concentrations if compound is present. For surrogates and spikes the LRL is in percent (pct.).]

| Compound | USGS parameter code | CAS number | Laboratory reporting level | |
|---|---|---|---|---|
| **Major-ions and selected trace elements** | | | | |
| Alkalinity. laboratory | 29801 | 471-34-1 | 8 | mg/L |
| Aluminum | 01106 | 7429-90-5 | 4 | µg/L |
| Arsenic [total dissolved As (V) + As (III)] | 01000 | 7440-38-2 | 0.06 | µg/L |
| Arsenic (V) | 62453 | 15584-04-0 | 0.8 | µg/L |
| Arsenic (III) | 62452 | 15502-74-06 | 0.8 | µg/L |
| Barium | 01005 | 7440-39-3 | 0.6 | µg/L |
| Boron | 01020 | 7440-42-8 | 2 | µg/L |
| Bromide | 71870 | 24959-67-9 | 0.02 | mg/L |
| Calcium | 00915 | 7440-70-2 | 0.02 | mg/L |
| Chloride | 00940 | 16887-00-6 | 0.12 | mg/L |
| Chromium | 01030 | 7440-47-3 | 0.12 | µg/L |
| Fluoride | 00950 | 16984-48-8 | 0.08 | mg/L |
| Iodide | 71865 | 7553-56-2 | 0.002 | mg/L |
| Iron | 01046 | 7439-89-6 | 4 | µg/L |
| Lithium | 01130 | 7439-93-2 | 0.06 | µg/L |
| Magnesium | 00925 | 7439-95-4 | 0.012 | mg/L |
| Manganese | 01056 | 7439-96-5 | 0.2 | µg/L |
| pH, laboratory | 00403 | -- | 0.1 | pH |
| Potassium | 00935 | 7440-09-7 | 0.06 | mg/L |
| Residue, 180 degrees Celsius (Total Dissolved Solids) | 70300 | -- | 10 | mg/L |
| Silica | 00955 | 7631-86-9 | 0.20 | mg/L |
| Sodium | 00930 | 7440-23-5 | 0.12 | mg/L |
| Specific conductance, laboratory | 90095 | -- | 5 | µS/cm |
| Strontium | 01080 | 7440-24-6 | 0.4 | µg/L |
| Sulfate | 00945 | 14808-79-8 | 0.18 | mg/L |
| Vanadium | 01085 | 7440-62-2 | 0.16 | µg/L |
| Uranium | 22703 | 7440-61-1 | 0.006 | µg/L |
| **Nutrients** | | | | |
| Nitrogen, ammonia as N | 00608 | 7664-41-7 | 0.02 | mg/L |
| Nitrogen, ammonia + organic nitrogen | 00623 | 17778-88-0 | 0.1 | mg/L |
| Nitrogen, nitrite | 00613 | 14797-65-0 | 0.002 | mg/L |
| Nitrogen, nitrite + nitrate | 00631 | | 0.04 | mg/L |
| Phosphorus | 00666 | 7723-14-0 | 0.04 | mg/L |
| Phosphorus, phosphate, ortho | 00671 | 14265-44-2 | 0.008 | mg/L |

Methods from Fishman and Friedman, 1989; Fishman, 1993; Garbino and others, 2002 and 2006.

EXHIBIT A

Task 5. Evaluation of Experimental Performance

The performance of the pond and the underlying unsaturated material to sorb arsenic will be evaluated on an ongoing basis during the study The breakthrough of arsenic in lysimeters at different depths will be compared to expected breakthrough estimated on the basis of alumina, iron, and manganese oxides measured in drill cuttings collected from the unsaturated zone and on the results of laboratory column experiments If arsenic is mobile and the sorption of arsenic differs unfavorably from expected sorption and removal of arsenic demonstrated in laboratory studies, the experiment can be stopped at any time and the approach reevaluated Decisions of this type will be made in close consultation with the Lahontan RWQCB to ensure the underlying groundwater resource is protected.

Task 6. Report Preparation

Data collected as part of Tasks 1 and 2 will need to be compiled and evaluated before water can be infiltrated from the proposed pond. Interim updates will be required to ensure arsenic is being removed as water infiltrates through the unsaturated zone. A final report will be prepared at the end of the study. The report will describe the effectiveness of *in-situ* removal of arsenic from water infiltrated at the site. Experimental data from laboratory studies will be related to data from field experiments and will be used to identify properties of unsaturated material that control sorption of arsenic. This information will be used to develop a methodology to transfer the approach to other areas. These areas include much of the western and interior plains area of the United States potentially benefiting as many as 5 % of the water systems in the United States serving about 11 million people Because of the cost benefits and relative simplicity of *in-situ* remediation the approach also may have significant transfer value to developing countries that have arsenic issues.

Task 7 Project Management

This task includes coordination of project activities between LACDPW - WW, the USGS, and AVEK. The task also includes quarterly reporting of project activities and preliminary results to the Water Research Foundation by LACDPWW □WW

## APPLICATIONS POTENTIAL

Results of this study will describe the effectiveness of *in-situ* removal of arsenic from groundwater The project will treat an estimated 3,200 acre-feet of groundwater with high levels of arsenic during the study If successful and approved for operation by the Lahontan RWQCB, approximately 100,000 acre-feet of water can be treated over the life of the project. The cost of treatment is the cost of pumping the water into the pond, which is about $150 per ac-ft, in 2008 dollars. Pond maintenance costs are expected to be minimal and limited to occasional removal of fines from the pond bottom. Ancillary benefits include depressurizing the deeper aquifer, thereby minimizing upward migration of poor-quality, high arsenic groundwater through confining clays or the annulus of abandoned or unpumped wells All arsenic from the pumped groundwater will remain on-site and no hazardous waste is expected to be generated

After *in-situ* treatment of groundwater with high levels of arsenic has been approved by the Lahontan RWQCB, similar projects are likely to be proposed to treat water from additional wells with similar concentrations of arsenic operated by LACDPW · WW and other water purveyors in the Antelope Valley The approach is likely to have a significant transfer value to other areas in the Mojave Desert and southwestern United States that have the same problem. The study will address basic research questions related to the physical movement of water through thick unsaturated zones and questions about arsenic chemistry, sorption, and long-term mobility of arsenic sorbed on surface exchange sites of mineral grains. These data will be used to develop a methodology to transfer the approach to other areas These areas include much of the western and interior plains area of the United States potentially benefiting as many as 5 % of the water systems in the United States serving about 11 million people. Because of the cost benefits and relative simplicity of *in-situ* remediation the approach also may have significant transfer value to developing countries that have arsenic issues

The proposed work is an extension of two recently successful USGS studies that: 1) recharged water table aquifers through thick unsaturated zones (Izbicki and others, 2008a), and 2) lowered arsenic concentrations in wells screened in the upper and lower aquifers by sealing the deeper parts of those wells (Stamos and others, written communication, 2008) If successful, this study will increase the groundwater supply available for public use in the Antelope Valley by restoring the beneficial use of the deep aquifer that was eliminated after the MCL for arsenic was lowered from 50 to 10 µg/L

## SUMMARY OF RELATED RESEARCH

Sorption of arsenic on alumina, iron, and manganese oxides is the basis of commercial resin technology used to remove arsenic from groundwater These oxides are naturally occurring on the surfaces of mineral grains (fig. 2) Sorption of arsenic to alluvial deposits has been observed under oxic conditions at the Oro Grande recharge site (Izbicki and others, 2008b) and to soils at other sites (McGeehan and others, 1998; Gimenez and others, 2007, Kniewald and Fiket, 2007) These studies showed sorption to occur within days under oxic, alkaline conditions and that naturally occurring alumina, iron, and manganese oxides have similar sorptive properties as synthetic sorbents

An artificial recharge experiment done in the Mojave Desert along Oro Grande Wash near Victorville, Calif (about 60 miles southeast of Lancaster) showed that it was possible to infiltrate water through the thick unsaturated zones commonly found in the Mojave Desert (Izbicki and others, 2008a) The Oro Grande site differed from many existing artificial recharge sites in that it was located away from highly permeable material found along major rivers and the unsaturated zone at the site contained numerous fine-grained layers and buried paleosols Surface infiltration rates for the pond were as much as 2 7 ft/day, with a maximum capacity of about 800 gal/min for a 0.9 acre pond with a residence time in the pond of about one day About three years were required for water to initially move through the unsaturated zone to the water table about 400 feet below land surface Once wetted, water moved through the unsaturated zone in about one year, a reasonable time frame for the management of imported water supplies. A pipeline is being built to bring imported water to the site and additional ponds are being constructed to increase the capacity of the site to allow for infiltration of larger volumes of imported water

The Oro Grande site differed from previous recharge sites operated in the Mojave Desert area of California in that it was located over a thick unsaturated zone containing fine-grained layers and was not initially considered suitable for large-scale groundwater recharge from ponds. Although the fine-grained layers decrease the permeability of the unsaturated zone and increased the lateral spreading of water as it moved downward to the water table, the fine-grained layers increased the surface area of the alluvial deposits encountered by infiltrating water Sorption of arsenic on alumina, iron, and manganese oxides on the surfaces of mineral grains reduced arsenic concentrations in water infiltrated from the pond from about 10 µg/L to less than 1 µg/L at the shallowest sampling depth 20 feet below the pond Arsenic concentrations at this depth remained below 10 µg/L throughout the experiment and the infiltration of 1,050 acre-feet of water (Izbicki and others, 2008a)

The estimated capacity of the proposed arsenic treatment pond presented in this proposal is derived from the results of the Oro Grande study This work will build on the Oro Grande study by specifically addressing the movement and chemistry of groundwater with high levels of arsenic water used for groundwater recharge. Ongoing recharge experiments using instrumented boreholes as deep as 500 feet are being performed by the USGS at sites near Yucca Valley and Joshua Tree, California. These ponds are being used to test the feasibility of recharge and associated changes in water quality in these areas using imported water from the California Aqueduct and treated municipal wastewater Additional sites in Yucca Valley and near El Mirage, California are being used to study recharge and water quality changes from septic and irrigation return water

## QUALITY ASSURANCE / QUALITY CONTROL



**Field Methods:** All field sampling techniques will follow protocols described in the "National Field Manual for the Collection of Water Quality Data", Chapters 1-9, F.D. Wilde and others, editors, U S, Department of the Interior, U S Geological Survey, 1997-2007 In addition, all USGS California District field personnel have ongoing personal QA/QC training and testing to ensure that all water quality data is collected according to the best possible protocols. Instruments installed in boreholes are calibrated using procedures described by Flint and others (2002) Matric potential data and water-level data will be collected at four-hour intervals. The water level data from pressure transducers will be confirmed with measurements made at six-week intervals during routine service at the site.

**Field Blanks, Equipment Blanks, and Duplicates**. The project will follow protocols established by the National Assessment of Water Quality (NAWQA) Program for the collection of blanks and duplicate samples. In general, for trips to the field in which fewer than ten water quality samples are taken, one each of Field Blank, Equipment Blank, and a Duplicate Sample will be taken and analyzed along with the water quality samples. For trips to the field in which greater than ten water quality samples are taken, one each of Field Blank, Equipment Blank, and a Duplicate Sample per ten water quality samples will be taken and analyzed along with the water quality samples.

**Analytical QA/QC:** All samples will be sent to the USGS National Water Quality Laboratory (NWQL) for analysis Details of the NWQL QA/QC protocols can be seen in the two attached appendices Appendix 2 Quality Control at the U S Geological Survey National Water Quality laboratory, Fact Sheet FS-026-98 (Pirkey and Glodt, 1998), and Appendix 3 Participation in Performance Evaluation Studies by U S Geological Survey National Water Quality Laboratory, Fact Sheet FS-023-98 (Glodt and Pirkey, 1998).

## SCHEDULE

The project will begin in summer 2009 and end in fall 2011 The project timeline by tasks is shown in Figure 5

| | 2009 | | | | 2010 | | | | 2011 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | W | S | S | F | W | S | S | F | W | S | S | F |
| **Task 1--Site selection and installation of an instrumented borehole** | | | | | | | | | | | | |
| Site selection | | | X | | | | | | | | | |
| Drilling and instrument installation | | | | X | | | | | | | | |
| **Task 2--Determination of physical and chemical properties of unsaturated materials** | | | | | | | | | | | | |
| Water extractions of soluble cations | | | | X | | | | | | | | |
| Acid extractions of trace elements | | | | X | | | | | | | | |
| Hydraulic property analysis | | | | X | | | | | | | | |
| **Task 3--Laboratory studies of arsenic sorption** | | | | | | | | | | | | |
| USGS radiological lab (contractual services) | | | | X | X | X | | | | | | |
| USDA Soil Salinity lab (contractual services) | | | | X | X | X | | | | | | |
| **Task 4--Data collection and monitoring** | | | | | | | | | | | | |
| Data logger installation (Labor) | | | | X | | | | | | | | |
| Instrument maintainence, site servicing and data collection | | | | X | X | X | X | X | X | X | X | X |
| **Task 5--Evaluation of experimental performance** | | | | | | | | | | | | |
| Project updates | | | | X | X | X | X | X | X | X | | |
| **Task 6--Report preparation** | | | | | | X | X | X | X | X | X | X |
| **Task 7--Project Management** | | | | X | X | X | X | X | X | X | X | X |

Figure 5.—Project timeline

## MANAGEMENT PLAN AND STATEMENT OF QUALIFICATIONS

The sponsoring utility for this research will be LACDPW - WW The principle investigator will be T.J Kim, Ph.D, P.E. LACDPW - WW Technical work will be performed by USGS personnel under a contract with LACDPW - WW John Izbicki, Ph.D is the co-PI and lead USGS investigator on the project.

The field work and arsenic chemistry portion of the project will be done using existing USGS staff in the San Diego office who are already working on groundwater recharge and arsenic issues in the Mojave Desert. This includes Peter Martin, John Izbicki, David O'Leary and Dennis Clark. Radiolabled arsenic experiments require special facilities and licenses; therefore, this work will be done in a USGS radiological lab in Menlo Park, Calif by Dr Thomas Kulp.

A list of key personnel involved in the project, their qualifications, contact information, and percentage of time committed to the project is provided on the following page. The lead USGS investigator, John Izbicki Ph.D., has completed numerous studies of natural and artificial groundwater processes in the Mojave Desert, Orange County, and the Central Valley of California near Stockton and Roseville. These studies address issues, including 1) the physical movement of water through thick unsaturated zones, 2) the physical movement of water through aquifers in response to infiltration from ponds and injection from wells (ASR), and 3) the nutrient, organic (including THM and THMFP), and trace-element chemistry of recharged water Dr Izbicki also has completed numerous studies on arsenic, chromium, and trace element geochemistry in the Mojave Desert and Central Valley of California. Dr Izbicki's publications are listed in the attached CV

Dan Lafferty, P.E.
Principal Engineer
Los Angeles County Dept. of Public Works
P.O Box 1460
Alhambra, CA 91802-1460
Work. (626) 300-4689
Fax. (626) 300-3385
Email: dlaff@dpw.lacounty.gov
% time: 5 (average over three years)

John Izbicki, Ph D
U.S. Geological Survey, WRD
4165 Spruance Road, Suite 200
San Diego, CA 92101
Work. (619) 225-6131
Fax. (619) 225-6101
Email. jaizbick@usgs.gov
% time: 25 (average over three years)

Peter Martin, M.S., R.G., C.H.G.
Desert Group Program Chief
U.S Geological Survey, WRD
4165 Spruance Road, Suite 200
San Diego, CA 92101
Work. (619) 225-6127
Fax. (619) 225-6101
Email. pmmartin@usgs.gov
% time: 10 (average over three years)

David O'Leary, R.G
Hydrologist
U.S. Geological Survey, WRD
4165 Spruance Road, Suite 200
San Diego, CA 92101
Work: (619) 225-6157
Fax (619) 225-6101
Email. doleary@usgs.gov
% time: 25 (average over three years)

Dennis A. Clark, B.S.
Hydrologic Technician
U.S. Geological Survey, WRD
4165 Spruance Road, Suite 200
San Diego, CA 92101
Work. (619) 225-6126
Fax. (619) 225-6126
Email. daclark@usgs.gov
% time 10 (average over three years)

Thomas R. Kulp, PhD
U.S. Geological Survey, WRD
4165 Spruance Road, Suite 200
Menlo Park, CA 92101
Work: (619) 225-6131
Fax: (619) 225-6101
Email: trkulp@usgs.gov
% time: 5 (average over three years)

T.J Kim, Ph.D., P.E.
Civil Engineer
Los Angeles County Dept. of Public Works
P.O Box 1460
Alhambra, CA 91802-1460
Work: (626) 300-3327
Fax. (626) 300-3385
Email: tjkim@dpw.lacounty.gov
% time: 10 (average over three years)

Clark Ajwani, B.S
Senior Civil Engineering Assistant
Los Angeles County Dept. of Public Works
P O Box 1460
Alhambra, CA 91802-1460
Work: (626) 300-4687
Fax: (626) 300-3385
Email: cajwani@dpw.lacounty.gov
% time: 15 (average over three years)

**Project Sponsor: Los Angeles County Department of Public Works - Waterworks**

**Project Title: IN-SITU ARSENIC REMOVAL ON UNSATURATED ALLUVIUM**

## *I. Project Participant Contribution Summary*

**THIS SECTION AUTOFILLS FROM THE INFORMATION ENTERED IN SECTIONS II AND III**

| | | |
|---|---|---|
| **A - Foundation Share** | $ 588,000 | This number is the sum total of all cash that will be managed by the Foundation and includes both Foundation and Co-Funder funds. *This amount should equal the Foundation Share share total in the completed Project Budget Form cost breakdown.* |
| **B - Cost Share** | $ 230,500 | This number represents the dollar value of all contractor cost share that will be provided to the project. This amount should equal the Cost Share total in the completed Project Budget Form summary sheet cost breakdown. |
| **C - Third Party Contributions** | $ 180,000 | This number represents the sum of Third-Party cash contributions and the dollar value of all non-cash in-kind services provided by Co-Funders and Third-Party Contributors. *This amount should equal* ***K - Third Party Contributions*** *on the Project Budget Form* |
| **D - Total Project Budget** | $ 998,500 | This number represents the total of all cash and in-kind funding that will be provided by the Foundation, Co-Funders, Third-Party Contributors and Contractor Cost Share. The **Project Budget Total** on the Project Budet Form *must* equal this value |

**Project Sponsor:** LA COUNTY DEPARTMENT OF PUBLIC WORKS

**Project Title:** IN-SITU ARSENIC REMOVAL ON UNSATURATED ALLUVIUM

**Co-Funder Contributions and Foundation Matching Guidelines:**

- ◇ Organizations wishing to provide cash for a project **and have the Foundation manage the cash** should be listed below.
- ◇ Organizations who are providing cash to the project and are full paying subscribers wishing to have the Foundation match their cash contribution should indicate their request below.
- ◇ Organizations that wish to provide cash to the project but **will not be sending the funds to the Foundation** to be managed with other project funds should be listed on worksheet III under Third-Party Contributions
- ◇ All money managed by the Foundation, including co-funder cash, should be accounted for as Foundation Share on the main project budget form.
- ◇ Co-funders also contributing in-kind services should provide a dollar value for the services in the area indicated below.

***SECTION II - Co-Funder Contribution and Requested Foundation Cash Match***

| Participant | Total | Co-Funder Cash | Foundation Cash Match | Co-Funder In-kind |
|---|---|---|---|---|
| Los Angeles County Department of Public Works - Waterworks | $ 588,000 | $ 438,000 | $ 150,000 | $ 95,500 |
| | $ - | | | |
| | $ - | | | |
| | $ - | | | |
| | $ - | | | |
| | $ - | | | |
| | $ - | | | |
| | $ - | | | |
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| | $ - | | | |
| | $ - | | | |
| | $ - | | | |
| | $ - | | | |
| | $ - | | | |
| | Total Carried to Section I.A | | OK | Total Carried to Section III.B |
| Totals | ⇩ | $ 438,000 | $ 150,000 | ⇩ |
| Foundation Share ☐ Co-Funder Cash + Foundation Cash Match (carries to Section I.A) | ☐ 588,000 | | | $ 95,500 |

**Project Sponsor** LA COUNTY DEPARTMENT OF PUBLIC WORKS

**Project Title:** IN-SITU ARSENIC REMOVAL ON UNSATURATED ALLUVIUM

**Third Party Contributions and Contractor Cost Share Guidelines:**

- Third party contributions can be made by any entity interested in either providing cash or in-kind services to the project.
- Organizations that wish to participate by providing in-kind services alone should be listed below along with the estimated value of the in-kind service.
- Organizations that wish to provide cash to the project but **will not be sending the funds to the Foundation** to be managed with other project funds should be listed below.
- Cash and in-kind services provided by project contractors should be indicated in Section III.B below.
- Cash provided by third parties must be accounted for on the main project budget form under the Cost Share column.

***SECTION III.A Third-Party Contributions***

| Participant | Cash | In-Kind Services | Total In-Kind |
|---|---|---|---|
| Antelope Valley East Kern (AVEK) Water Agency | | $180,000.00 | $ 180,000 |
| | | | $ - |
| | | | $ - |
| | | | $ - |
| | | | $ - |
| | | | $ - |
| | | | $ - |
| | | | $ - |
| | | | $ - |
| | | | $ - |
| | | | $ - |
| **Total Third-Party Cash** | $0.00 | | |
| **Total Third-Party In-Kind** ⇨ | | $180,000.00 | |
| **Total Third-Party In-Kind Services** (carries to section I.C) | | | $ 180,000 |

***SECTION III.B Contractor Cost Share***

| Participant | Total |
|---|---|
| U.S. Geological Survey | $ 135,000 |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| Co-Funder In-Kind carried from Section II ⇨ | $ 95,500 |
| **Total Cost Share** (Carries to Section I.B) | **230,500** |

**Applicant Name:** LACDPW-WW

*** Required fields are highlighted in yellow.**

**Foundation Project Name:** IN-SITU ARSENIC REMOVAL ON UNSATURATED ALLUVIUM

**Foundation RFP # (if applicable):** 4299

**Note: The information above will carry over to subsequent pages/worksheets. All totals below will be automatically populated from the following pages/worksheets.**

| | | Total | Foundation Share | Cost-Share |
|---|---|---|---|---|
| A | Key Personnel | 39,312.00 | - | 39,312.00 |
| B | Other Personnel | 56,160.00 | - | 56,160.00 |
| | *Total Direct Labor and Fringe Benefits* | 95,472.00 | - | 95,472.00 |
| C | Equipment Rental | - | - | - |
| | Special Equipment | - | - | - |
| D | Materials and Supplies | - | - | - |
| E | Travel | - | - | - |
| F | Subcontracts | 722,992 00 | 588,000.00 | 134,992.00 |
| G | Other Direct Costs | | - | - |
| | *Total Direct Costs* | 818,464.00 | 588,000.00 | 230,464.00 |
| H | Indirect Costs | - | - | - |
| I | Fee | - | - | - |
| J | Surveys | - | - | - |
| | ***Total Direct and Indirect Costs*** | **818,464.00** | **588,000.00** | **230,464.00** |
| K | Third-Party Contributions | 180,000.00 | n/a | n/a |
| | ***Total Project Budget*** | **998,464.00** | | |

REVISED
3-29-10

**Applicant Name:** LACDPW-WW *** Required fields are highlighted in yellow.**

**Foundation Project Name:** IN-SITU ARSENIC REMOVAL ON UNSATURATED ALLUVIUM

**Foundation RFP #** 0

***A. Key Personnel*** ***(Principal Investigator and Co-PIs only)***

| Name | Project Role | Number of Hours | Direct Hourly Rate | % Time Allocated to Project | Subtotal Direct Labor | Fringe Benefit % of Direct Labor | Subtotal Fringe Benefits | Total | Foundation Share | Cost-Share |
|---|---|---|---|---|---|---|---|---|---|---|
| T.J. Kim | | 624.00 | 63.00 | 10% | 39312.00 | | 0.00 | 39312.00 | 0.00 | 39312.00 |
| | | | | | 0.00 | | 0.00 | 0.00 | | |
| | | | | | 0.00 | | 0.00 | 0.00 | | |
| | | | | | 0.00 | | 0.00 | 0.00 | | |
| NOTE: the percent of time varies with project year | | | | | 0.00 | | 0.00 | 0.00 | | |
| | | | **Total Key Personnel** | | 39312.00 | | 0.00 | 39312.00 | 0.00 | 39312.00 |

***B. Other Personnel***

| Name/Position | Project Role | Number of Hours | Direct Hourly Rate | % Time Allocated to Project | Subtotal Direct Labor | Fringe Benefit % of Direct Labor | Subtotal Fringe Benefits | Total | Foundation Share | Cost-Share |
|---|---|---|---|---|---|---|---|---|---|---|
| Dan Lafferty | | 312.00 | 73.50 | 5% | 22932.00 | | 0.00 | 22932.00 | 0.00 | 22932.00 |
| Clark Ajwani | | 936.00 | 35.50 | 15% | 33228.00 | | 0.00 | 33228.00 | 0.00 | 33228.00 |
| | | | | | 0.00 | | 0.00 | 0.00 | | |
| | | | | | 0.00 | | 0.00 | 0.00 | | |
| | | | | | 0.00 | | 0.00 | 0.00 | | |
| | | | | | 0.00 | | 0.00 | 0.00 | | |
| | | | | | 0.00 | | 0.00 | 0.00 | | |
| | | | | | 0.00 | | 0.00 | 0.00 | | |
| | | | | | 0.00 | | 0.00 | 0.00 | | |
| | | | | | 0.00 | | 0.00 | 0.00 | | |
| | | | | | 0.00 | | 0.00 | 0.00 | | |
| | | | | | 0.00 | | 0.00 | 0.00 | | |
| | | | | | 0.00 | | 0.00 | 0.00 | | |
| NOTE: the percent of time varies with project year | | | | | 0.00 | | 0.00 | 0.00 | | |
| | | | | **Total Other Personnel** | 56160.00 | | 0.00 | 56160.00 | 0.00 | 56160.00 |

REVISED
3-29-10

EXHIBIT A

**Applicant Name:** LACDPW-WW *** Required fields are highlighted in yellow.**

**Foundation Project Name:** IN-SITU ARSENIC REMOVAL ON UNSATURATED ALLUVIUM

**Foundation RFP #** 0

## *C. Equipment Rental and Special Equipment Purchase*

| Equipment Rental (*List items and dollar amount for each item exceeding $1,000)* | Total | Foundation Share | Cost-Share |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| **Total Equipment Rental** | 0.00 | 0.00 | 0.00 |

| Special Equipment Purchase *(List items and dollar amount for each item exceeding $5,000)* | Total | Foundation Share | Cost-Share |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| **Total Special Equipment Purchase** | 0.00 | 0.00 | 0.00 |

REVISED
3-29-10

**Applicant Name:** LACDPW-WW *** Required fields are highlighted in yellow.**

**Foundation Project Name:** IN-SITU ARSENIC REMOVAL ON UNSATURATED ALLUVIUM

**Foundation RFP #** 0

| *D. Materials and Supplies* | Total | Foundation Share | Cost-Share |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| **Total Materials and Supplies** | 0.00 | 0.00 | 0.00 |

| *E. Travel* | Total | Foundation Share | Cost-Share |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| **Total Travel** | 0.00 | 0.00 | 0.00 |

REVISED
3-29-10

Applicant Name: LACDPW-WW * Required fields are highlighted in yellow.

Foundation Project Name IN-SITU ARSENIC REMOVAL ON UNSATURATED ALLUVIUM

Foundation RFP # 0

| *F Subcontracts* | Total | Foundation Share | Cost-Share |
|---|---|---|---|
| US Department of Agriculture Soil Salinity Laboratory arsenic sorption studies | 30000.00 | 21000.00 | 9000.00 |
| US Geological Survey, National Research Program, radiolabled arsenic studies | 10000.00 | 7000.00 | 3000.00 |
| US Geological Survey Lead scientist | 207900.00 | 145530.00 | 62370.00 |
| US Geological Survey Lead hydrologic technician | 45000.00 | 31500.00 | 13500.00 |
| US Geological Survey Analytical chemist | 23072.00 | 16150.00 | 6922.00 |
| US Geological Survey Assistant hydrologist | 47580.00 | 33306.00 | 14274.00 |
| US Geological Survey Hydrologic technician 2 | 18480.00 | 12936.00 | 5544.00 |
| US Geological Survey Hydrologic technician 3 | 13260.00 | 9282.00 | 3978.00 |
| US Geological Survey Hydrologic technician 4 | 5000.00 | 3500.00 | 1500.00 |
| US Geological Survey, National Water Quality Laboratory, analytical expenses | 49500.00 | 48846.00 | 654.00 |
| US Geological Survey, California WSC, hydraulic property analysis | 8700.00 | 8700.00 | 0.00 |
| Sample shipment 24-hour delivery via FED-Ex | 1500.00 | 1050.00 | 450.00 |
| US Geological Survey California WSC drill rig charges | 199000.00 | 199000.00 | 0.00 |
| Drill charges--suction-cup lysimeters, heat-dissipation probes (inc. calibration), DEEP sensors, advanced tensiomenters | 18000.00 | 18000.00 | 0.00 |
| Drill charges--supplies for drilling including well-construction materials (sand, grout, ect.), permits | 5000.00 | 3500.00 | 1500.00 |
| Cellular communications | 500.00 | 350.00 | 150.00 |
| Data logger | | | |
| Supplies for field collection of water-quality samples | 9300.00 | 6510.00 | 2790.00 |
| Supplies for laboratory extractions | 3000.00 | 2100.00 | 900.00 |
| Sample pumps operation and deployment | 2000.00 | 1400.00 | 600.00 |
| Field vehicles, gasoline, mileage | 4050.00 | 2835.00 | 1215.00 |
| Site visits for field personnel to collect water samples at 6-week intervals | 5400.00 | 3780.00 | 1620.00 |
| Visits from project staff to provide data updates and coordination with cooperator | 1350.00 | 945.00 | 405.00 |
| Cellular communications | 1000.00 | 700.00 | 300.00 |
| Travel associated with well drilling and installation | 10800.00 | 7560.00 | 3240.00 |
| Field vehicles, gasoline, mileage associated with well drilling and installation | 3600.00 | 2520.00 | 1080.00 |
| **Total Subcontracts** | 722992.00 | 588000.00 | 134992.00 |

| *G. Other Direct Costs* | Total | Foundation Share | Cost-Share |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| **Total Other Direct Costs** | 0.00 | 0.00 | 0.00 |

REVISED
3-29-10

EXHIBIT A

**Applicant Name:** LACDPW-WW *** Required fields are highlighted in yellow.**

**Foundation Project Name:** IN-SITU ARSENIC REMOVAL ON UNSATURATED ALLUVIUM

**Foundation RFP #** 0

***H. Indirect Costs*** *(Attach copy of federally approved rates or detailed basis for rates)*

| Cost Category | Rate % | Base $ | Total | Foundation Share | Cost-Share |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| Total Indirect Costs | | | 0.00 | 0.00 | 0.00 |

| *I. Fee* | Total | Foundation Share | Cost-Share |
|---|---|---|---|
| | | | |
| Total Fee | 0.00 | 0.00 | 0.00 |

| J. Survey | Total | Foundation Share | Cost-Share |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| Total Survey Costs | 0.00 | 0.00 | 0.00 |

REVISED
5-29-10

**Applicant Name:** LACDPW-WW *** Required fields are highlighted in yellow.**

**Foundation Project Name:** IN-SITU ARSENIC REMOVAL ON UNSATURATED ALLUVIUM

**Foundation RFP #** 0

***K. Third-Party Contributions***

| Participant | Total | In-Kind Services | Cash |
|---|---|---|---|
| Land, water, electricity, and water delivery costs provided by Antelope Valley East Kern (AVEK) Water Agency | 180000.00 | | 180000.00 |
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| **Total Third-Party Contributions** | 180000.00 | 0.00 | 180000.00 |

REVISED
3-29-10

**Budget Narrative**

The total costs for this study are estimated to be $998,500 The study is expected to take three years to complete. Costs, including in-kind charges for land, water. electricity, and water delivery provided by Antelope Valley East Kern (AVEK) Water Agency, are summarized by Task in the following table.

| Task | Total |
|---|---|
| **Land, water, electricity, and delivery costs** (In-kind services AVEK) | $180,000 |
| **Task 1**—Site selection and installation of an instrumented borehole | 280,000 |
| **Task 2**—Determination of physical and chemical properties of unsaturated materials | 32,000 |
| **Task 3**—Laboratory studies of arsenic sorption | 40,000 |
| **Task 4**—Data collection and monitoring | 196,000 |
| **Task 5**—Evaluation of experimental performance | 75,000 |
| **Task 6**—Report preparation | 100,000 |
| **Task 7**—Project Management | 95,500 |
| **Total** | **$998,500** |

An additional breakdown of costs by budget categories, such as salaries, supplies, services, travel, and other costs is provided in Table 3

For studies done in cooperation with local agencies, the USGS has funding to share costs for certain expenses, such as labor and travel associated with Tasks 1 through 6, to a maximum of 30 percent of the cost for that expense. Costs related to drilling or analytical costs are not usually shared Depending on the availability of cooperative funding, the maximum potential contribution from the USGS is

| | Total |
|---|---|
| **Maximum Potential** | |
| **U.S. Geological Survey contribution** | **□135,000** |
| **Cooperator contribution (assuming maximum U.S. Geological Survey contribution)** | **□438,000** |
| **Cooperator In-kind contribution** | **□95,500** |
| **Foundation contribution** | **□150,000** |
| **In-kind services AVEK** | **□180,000** |

Allocation of Federal matching funds by the USGS within California is done on a competitive basis, during which potential projects are evaluated on the basis of societal need, technical soundness, scientific merit, and other factors in conformance with the District science plan The proposed work has been accepted for funding using Federal matching funds.

Table 3 —Costs by Task and budget category

| | | Cost |
|---|---|---|
| **Land rental, water, electricity, and water delevery charges** | | $180,000 |
| (In-kind services provided by AVEK) | | |
| **Task 1--Site selection and installation of an instrumented borehole** | | |
| Labor (includes site selection and review of well data and water quality data) | | 18,600 |
| Labor (onsite geologists for well logging and drill sample collection) | | 40,742 |
| Travel, per diem, and vehicles | | 12,550 |
| Drill rig charges (detailed in budget narrative) | | 204,070 |
| Miscellaneous supplies and equipment | | 4,038 |
| | *Subtotal* | $280,000 |
| **Task 2--Determination of physical and chemical properties of unsaturated materials** | | |
| Labor (includes labor for analytical costs in San Diego lab) | | 18,300 |
| Chemical analysis | | 2,000 |
| Hydraulic property analysis | | 8,700 |
| Supplies and equipment (laboratory supplies) | | 3,000 |
| | *Subtotal* | $32,000 |
| **Task 3--Laboratory studies of arsenic sorption** | | |
| USGS radiological lab (contractual services) | | 10,000 |
| USDA Soil Salinity lab (contractual services) | | 30,000 |
| | *Subtotal* | $40,000 |
| **Task 4--Data collection and monitoring** | | |
| Labor | | 109,000 |
| Travel per diem, and vehicles | | 10,300 |
| Chemical analysis | | 49,500 |
| Supplies and equipment (for water quality sample collection) | | 9,300 |
| Data logger and electronics purchase | | 12,900 |
| Data logger installation (Labor) | | 3,000 |
| Miscellaneous supplies and equipment | | 2,000 |
| | *Subtotal* | $196,000 |
| **Task 5--Evaluation of experimental performance** | | |
| Labor (including quarterly updates) | | 73,650 |
| Travel, per diem, and vehicles | | 1,350 |
| | *Subtotal* | $75,000 |
| **Task 6--Report preparation** | | |
| Labor | | 98,000 |
| Travel and per diem | | 2,000 |
| | *Subtotal* | $100,000 |
| **Task 7--Project management** | | |
| Labor | | $95,500 |
| | **Total costs** | $998,500 |

The following narrative describes the source for estimates of costs detailed in the budget worksheets

Drilling costs and instrument installation costs occur only in 2009 The estimates for these expenses are detailed in Tables 4 and 5, respectively The project will use the U S Geological Survey drill rig based in Las Vegas, Nevada The drill rig is equipped for ODEX drilling a highly specialized type of drilling that does not use water as a drilling fluid Experience in drilling more than 20 holes of this type has shown that many items

such as the drill bit and casing shoe need to be replaced after each ODEX drill hole and that frequent on-site maintenance and off-site machining is required to ensure the casing, drill bit, and drill shoe withstand the stresses of the operation. Approximately 12, 12-hour drill-days are required to complete a hole of the type proposed for this project. The instrument installation techniques to be used as part of this project are highly specialized and not commercially available. The instruments purchased for this study are permanently installed in the borehole and cannot be retrieved. Many of these instruments are of custom manufacture available from only a single source and must be individually calibrated to meet the performance specifications required for this project. In many cases the wires and/or tubing required to connect the instruments to land surface are more expensive than the instrument. These instruments require data loggers, power, and electronic storage on the surface to function. Substitution for lower-cost equipment from other vendors would jeopardize the functionality of the instrumented borehole.

Table 4 —Drill rig charges (cost detail for Task 1, Table 3)

| Item | cost | estimate |
|---|---|---|
| Permits | | 1,500 |
| Mobilization | | 6,250 |
| Drill rig charges (12 hour day for 12 days) | 850/hr | 122,400 |
| Supplemtary compresser (for ODEX drilling) | 1560 / d | 18,720 |
| Drilling bits and ODEX drill shoe | | 15,000 |
| Drilling supplies (sand, grout, other backfill materials) | | 10,000 |
| Security | | 6,600 |
| Miscellaneous (sanitary facilities, noise control, security fencing, on-site repairs, and machining costs for repairs for drill bit, drill shoe, and ODEX casing) | | 7,500 |
| Logging charges (neutron log, gamma log, electromagnetic log) | | 4,500 |
| Perdiem for drill crew (3 people for 12 days) | | 5,400 |
| Vault and other construction materials to finish site | | 5,000 |
| Well and site development | | 1,200 |
| Total | | 204070 |

Table 5.—Data logger and electronics purchases (cost detail for Task 4 Table 3)

| Instrument | Vendor | Model | Number | Cost |
|---|---|---|---|---|
| data logger | Campbell Scientific | CR-3000 | 1 | 2900 |
| Channel excitation module | Campbell Scientific | CE-8 | 1 | 300 |
| 2GB compactflash memeory card | Campbell Scientific | CFMG-C2G | 1 | 280 |
| Instrument box | Campbell Scientific | ENC 16/18 | 1 | 150 |
| Deep-cycle marine batteries | generally available | | 4 | 300 |
| Pressure transducer for watrer-table well, plus cable ($0.50 / ft) | Electronic Engineering Innovations (EEI) | custom | 1 | 500 |
| Pressure transducer for advanced tensiometers, plus cable ($0.50 / ft) | Electronic Engineering Innovations (EEI) | custom | 3 | 1500 |
| Heat-dissipation probes, plus cable ($0.50 / ft), plus calibration | Campbell Scientific / calibration custom | 229-L | 6 | 3 520 |
| DEP (Di-Electric Permitivity) Sensors plus cable ($0.50 / ft) plus calibration | Decagon Devices Inc / calibration custom | MPS-1 | 8 | 3.450 |
| | | Total | | 12900 |

Laboratory analysis of hydraulic properties from drill cores and cutting material will be incurred in 2009 and 2010 These costs are listed in Table 6 Analysis for soluble anions from water extractions of drill cuttings will be analyzed in the U S Geological Survey laboratory in San Diego, Calif The costs for these analyses are primarily for labor charges for an analytical chemist and for supplies and materials for sample preparation and laboratory consumables as listed in the spreadsheet The costs for analysis of selected trace elements are listed in Table 7 as part of the laboratory analytical expenses.

Table 6 —Hydraulic property analysis (cost detail for Task 2, Table 3)

| General description | Cost | Frequency | Total cost |
|---|---|---|---|
| Physical properties (water content bulk density, porosity) | 110 | 10 | $1 100 |
| Particle-size | 210 | 10 | 2 100 |
| Water potential | 60 | 10 | 600 |
| Saturated hydraulic conductivity | 270 | 5 | 1 300 |
| Unsaturated hydraulic conductivity | 1800 | 2 | 3.600 |
| **Total** | | | $8 700 |

The costs associated with Task 3 are contractual costs for analysis to be done at the U S Department of Agriculture Soil Salinity Laboratory in Riverside, California and a U S Geological Survey National Research Program radiological laboratory in Menlo Park, California. These are highly specialized laboratories that are equipped and licensed for the analyses required as part of this study These analyses are not commercially available Because these laboratories are fully equipped, costs associated with Task 3 are primarily labor costs within the laboratories, with the exception of minor consumables and cost for radiolabled arsenic-73 to be used in the Menlo Park laboratory The cost of arsenic-73 including shipment is $1,750

Analytical costs occur throughout the project. Analysis of water samples collected in the field (and from acid extractions of drill cutting) will be done at the U S Geological Survey National Water Quality Laboratory in Denver, Colorado We are required to use this laboratory for quality assurance purposes for studies done with the U S Geological Survey The costs and likely frequency for analysis are listed in Table 4 Because it is difficult to predict the frequency and volume of water extracted from suction-cup lysimeters the actual frequency of analysis may differ from that listed in Table 7

Table 7—Chemical analysis (cost detail for Task 4, Table 3)

| Laboratory analytical schedule | General description | Cost | Frequency | Total cost |
|---|---|---|---|---|
| Schedule 1261 | Major-ions, and selectede trace elements | 440 | 20 | $8 800 |
| Schedule 1043 | Nutrients | 100 | 20 | 2 000 |
| Selected trace elements (As, Cr V Fe U, Mn) – environmental samples | | 112 | 170 | 19,040 |
| Selected trace elements (As, Cr V Fe U, Mn) – sequential extraction samples | | 113 | 40 | 4 520 |
| Selected trace elements TCLP (Toxicity Charactenzation Leaching Protocal) | | 112 | 28 | 3 130 |
| Lab code 2735 and 2734 | Arsenic (III) / Arsenic (V) | 313 | 30 | 9 390 |
| Schedule 1142 | delta Oxygen-18 and delta Deuterium | 131 | 20 | 2 620 |
| | Total for FY-09 through FY-11 | | | $49,500 |

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**Education:**

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| Ph D | 2000 | Water and Soil Science | University of California, Riverside, CA |
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| 2001-present | Research Hydrologist | U.S. Geological Survey, WRD, San Diego, CA |
| 1991 - 2001 | Hydrologist | U.S. Geological Survey, WRD, San Diego, CA |
| 1991 - 1989 | Water Quality Specialist | U.S. Geological Survey, WRD, Boston, MA |
| 1989 - 1985 | Hydrologist | U.S. Geological Survey, WRD, Boston, MA |
| 1985 - 1981 | Hydrologist | U.S. Geological Survey, WRD, Laguna Niguel, CA |
| 1980 - 1981 | Hydrologic Technician | U.S. Geological Survey, WRD, Towson, MD |

**Adjunct Professor San Diego State University:** 2008 to present
4 current graduate students
Lecturer in Isotope Hydrology

**Current Projects (Selected):**

*San Joaquin Chlorides* Determine the source of high-chloride water to wells in the Eastern San Joaquin Groundwater Subbasin using a combination of geologic (including test-drilling and well installation), geophysical (including borehole EM-induction logging, well-bore flow logging, and depth-dependent sample collection from pumping wells), and geochemical (including age-dating, chloride, and bromide isotopes) approaches. Evaluate recharge processes within the subbasin to determine effective methods of recharging the aquifer and controlling invasion of high-chloride water

*Santa Barbara Microbiology.* Determine the source of high fecal indicator bacteria in urban streams and recreational ocean beaches in the Santa Barbara using a combination of physical hydrology, isotope hydrology (including radon and radium isotopes), and microbiological (including genetic, molecular, and chemical) approaches.

*El Mirage Chromium* Determine the source of high-chromium ground water in an alluvial aquifer eroded from mafic rock The study sites are at dairies near area of known anthropogenic chromium contamination. The approach includes collection of physical and chemical data from the unsaturated zone underlying areas where dairy wastewater is disposed, isotope hydrology (including chromium isotopes), and microbiology. Microbiological work is addressing the relation between chemical exchange processes and interference in the microbialy mediated reduction of Cr(VI) in the presence of high-nitrate ground water

*Natural and artificial recharge of ground water* This represents a long series of studies primarily in the Mojave Desert of California that address the movement of water through thick (upto 400 ft) unsaturated zones. Recently completed has focused on the physical movement of water and soluble salts (primarily chloride, and nitrate) through the unsaturated zone in response to artificial recharge. On-going work is focused on the movement and microbially mediated transformation of nitrate from septic systems, and on the sorption of arsenic in thick unsaturated zones.

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# T.J. Kim, Ph.D., P.E.

Education

Ph.D., Civil Engineering, University of California, Irvine, 1998

M.S., Engineering, University of California, Irvine, 1994

B.S., Chemical Engineering, Korea University, 1992

Registration

Professional Engineer, Civil, California, 2002

Experience

10 years

## Experience Summary

T.J Kim has 10 years of experience conducting and supervising work related to Total Maximum Daily Loads (TMDLs), Municipal Stormwater NPDES permits, stormwater quality monitoring and management, and drinking water quality monitoring and regulatory compliance. He served on steering committees responsible for oversight of stormwater quality monitoring and technical studies in support of TMDL development for watersheds including Ballona Creek, Marina del Rey, Dominguez Channel, Los Angeles River, Santa Clara River, Santa Monica Bay, and San Gabriel River. Dr. Kim participated in study development, data review and interpretation, and analysis and oversight of study results. These studies included assessment of water quality impairment, identification and analysis of sources of water quality impairment, analysis of load allocation alternatives, and technical and regulatory analysis of implementation alternatives. He also evaluated various treatment technologies for removal of total trihalomethanes and arsenic in drinking water; assessed treatability of source water; established regulatory compliance strategies for the Los Angeles County Waterworks Districts.

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Los Angeles County Department of Public Works, Waterworks Division, Alhambra, California

*Civil Engineer* Mr. Kim serves as supervisor of a professional staff of engineers responsible for drinking water quality monitoring and regulatory compliance for the Department's Waterworks Districts. Responsibilities included preparation of water supply permit amendments for treatment and blending facilities, evaluation of treatment technologies for removal of total trihalomethanes (TTHMs) and arsenic in drinking water, development of capital improvement projects associated with drinking water regulatory compliance, oversight of drinking water quality monitoring and preparation of various water quality reports.

Brown and Caldwell, Los Angeles, California

*Principal Engineer:* Mr. Kim worked on the following projects:

- Countywide Integrated Regional Water Management Plan and Funding Plan, Los Angeles County Watershed Funding Workgroup, Los Angeles, California *(Deputy Program Manager)*
- Storm Water Management Plan, Theodore Payne Foundation for Wild Flowers and Native Plants, Inc., Sun Valley, California *(Project Manager)*
- Watershed Management Plan, City of Santa Monica, California *(Project Engineer)*

- Statewide Facilitation for CASQA Members Regarding SWRCB's Prohibition of Stormwater Dischargers to ASBS, California *(Project Engineer)*
- Lompoc Regional Wastewater Reclamation Plant Upgrade Project, Permitting Assistance, City of Lompoc, California *(Task Engineer)*

Los Angeles County Department of Public Works, Watershed Management Division, Alhambra, California

*Associate Civil Engineer.* T.J. Kim represented the Department in many technical meetings related to stormwater quality studies and analyses required for TMDL development; reviewed and critiqued TMDL regulations and relevant policies proposed by the Los Angeles Regional Water Quality Control Board (LARWQCB), the SWRCB, and the US EPA; analyzed their impacts on Department operation; and prepared comments and/or response letters. Mr. Kim also participated in the negotiation of the 2001 Los Angeles County Municipal Stormwater NPDES permit to design an effective stormwater quality monitoring program. The monitoring program included mass emissions, water column toxicity monitoring, tributary monitoring, estuary monitoring, bioassessment, new development impacts study, peak discharge impact study, and BMP effectiveness study. Mr. Kim performed various statistical analyses of stormwater quality data to identify constituents of concern, analyze stormwater quality trends, and support stormwater quality discussions included in the Annual Stormwater Monitoring reports submitted to the LARWQCB. T.J. Kim also designed and built a stormwater quality data management application in MS Access; performed data management tasks related to entry and storage of stormwater quality data set, invoice reconciliation, and tracking stormwater samples; and performed studies to calibrate and test GIS-based Pollutant Loading Model and Pollutant Source Identification Model, which were developed to provide technical information to effectively implement NPDES permit requirements.

University of California, Irvine, California

*Research Assistant.* T.J. Kim conducted numerical investigation of temporally and spatially variable mass transfer rate coefficients applicable to nonaqueous phase liquid pool dissolution in saturated porous media, and developed numerical modeling of water displacement by methanol in saturated soil columns for vertical as well as horizontal flow orientations, accounting for the mixed fluid density and viscosity variations. Mr. Kim delivered presentations of the research results in the department and in conferences.

## Publications/Presentations

**(a) Peer Review Journal Papers:**

A3 CONSTANTINOS V CHRYSIKOPOULOS and TAE-JOON KIM, Local mass transfer correlations for nonaqueous phase liquid pool dissolution in saturated porous media, Transport in Porous Media, 38, 167-187. 2000.

A2 TAE-JOON KIM and CONSTANTINOS V CHRYSIKOPOULOS, Mass transfer correlations for nonaqueous phase liquid pool dissolution in saturated porous media, Water Resources Research, 35(2), 449-459, 1999.

A1 THOMAS C. HARMON, TAE-JOON Kim, BRIAN K. DELA BARRE, and CONSTANTINOS V CHRYSIKOPOULOS, Cosolvent-water displacement in one-dimensional soil column, Journal of Environmental Engineering (ASCE), 125(1), 87-91, 1999.

**(b) Conference Proceedings:**

B4 CONSTANTINOS V CHRYSIKOPOULOS and TAE-JOON KIM, A local mass transfer correlation for nonaqueous phase liquid pool dissolution in saturated porous media, Proceedings of the 1998 Symposium on Environmental Models and Experiments Envisioning Tomorrow (EnviroMEET '98), edited by C. V Chrysikopoulos, T C. Harmon, and J. Bear, pp. 43-54, Irvine, CA, 1998.

B3 CONSTANTINOS V CHRYSIKOPOULOS and TAE-JOON KIM, Correlations for mass transfer coefficients applicable to NAPL pool dissolution in subsurface formations, in Computational Methods in Water Resources XII, Volume 1-Computational Methods in Contamination and Remediation of Water Resources, edited by V N. Burganos, G. P Karatzas, A. C. Payatakes, W. G. Gray, and G. F. Pinder, pp. 183-190, Computational Mechanics Publications, Southampton, UK, 1998.

B2 TAE-JOON KIM and CONSTANTINOS V CHRYSIKOPOULOS, Overall mass transfer correlations for dissolving elliptic/circular nonaqueous phase liquid pools in saturated porous media, Eighteenth Annual American Geophysical Union Hydrology Days, edited by H. J. Morel-Seytoux, pp. 153-163, Fort Collins, CO, 1998.

B1 TAE-JOON KIM, CONSTANTINOS V. CHRYSIKOPOULOS and THOMAS C. HARMON, Dynamics of miscible displacement by methanol in water saturated one-dimensional soil columns, Seventeenth Annual American Geophysical Union Hydrology Days, edited by H. J. Morel-Seytoux, pp. 161-170, Fort Collins, CO, 1997

**(c) Poster Presentations:**

C2 TAE-JOON KIM and CONSTANTINOS V CHRYSIKOPOULOS, Mass transfer correlations for single component NAPL pool dissolution in subsurface formations (Abstract), EOS, Transactions, American Geophysical Union, 78(46), 292, 1997

C1 THOMAS C. HARMON, TAE-JOON KIM, BRIAN K. DELA BARRE, and CONSTANTINOS V CHRYSIKOPOULOS, Investigation of miscible, inhomogeneous fluid displacement in one-dimensional soil columns (Abstract), EOS, Transactions, American Geophysical Union, 77(46), 202, 1996.

ANTELOPE VALLEY - EAST KERN WATER AGENCY
AVEK
ESTABLISHED 1959

A PUBLIC AGENCY



April 21. 2009

Mrs. Shonnie Cline, Senior Account Manager
Water Research Foundation (formerly AwwaRF)
6666 West Quincy Avenue
Denver, CO 80235

RECEIVED
APR 2 7 2009
Water Research Foundation

Re: Tailored Collaboration Program

Dear Mrs. Cline:

On behalf of the Antelope Valley-East Kern Water Agency (AVEK), I would like to express our support of the Antelope Valley in-Situ Arsenic Removal Project proposed by Los Angeles County Waterworks Districts, the United States Geological Survey, and AVEK Water Agency (AVEK) under the Water Research Foundation's Tailored Collaboration Program.

AVEK is a wholesale supplier of State Water Project (SWP) water to the Antelope Valley Region, and our service area encompasses nearly 2,400 square miles in northern Los Angeles and eastern Kern Counties as well as a small portion of Ventura County We provide water to a population of approximately 285,000 persons through seventeen retail water agencies and water companies with the majority of our customers residing in the Antelope Valley. Acknowledging the need for a more comprehensive, integrated solution, stakeholders, like AVEK, have developed an Integrated Regional Water Management (IRWMP) plan to address a multitude of problems and solutions related to water and other resource management, and a critical objective of the plan involves the assessment and stabilization of our ground water supply.

AVEK Water Agency believes that the In-Situ Arsenic Removal Project has the potential to provide helpful information that will help meet the water quality and water supply objectives concerning ground water management. AVEK is very interested in the future impact of water banking in the Antelope Valley and how it will be helpful toward replenishing our vulnerable ground water basin This proposed project would be a valuable asset toward implementing future ground water banking projects to help stabilize the Antelope Valley ground water basin. The proposed project may demonstrate arsenic removed sufficient for banking which will increase the amount of water available to be stored for future demands. The information from the study will help manage our resources in the Antelope Valley, and thus, ensure a better future for our customers.

The Agency is happy to provide the project partners with information related to the Antelope Valley watershed so that the information may be used to support the proposed In-Situ Arsenic Removal Project. The Agency will also provide the project partners with in-kind support in the form of a recharge site and use of an agricultural well, which is worth approximately $180,000.00. We request that you consider the potential impact that this project would have on our community and our expressed support of this project while evaluating the grant application.

Sincerely,

Russell E. Fuller
General Manager

6500 WEST AVENUE N • PALMDALE, CALIFORNIA 93551
(661) 943-3201 • FAX (661) 943-3204

EXHIBIT

## IN-KIND SUPPORT FORM (FOR NON-CASH CONTRIBUTIONS)

| Name of Organization | Name of Contact | Amount Specified in Letter of Commitment (USD$) |
|---|---|---|
| Antelope Valley East Kern Water Agency | Russell E. Fuller | 180,000.00 |
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| | Total Utility and other Organization In-kind ($) | 180,000.00 |

*Please note: Letters of commitment that specify dollar amount must be included with proposal for all in-kind included on this worksheet.

# COUNTY OF LOS ANGELES

## DEPARTMENT OF PUBLIC WORKS

*"To Enrich Lives Through Effective and Caring Service"*

GAIL FARBER, Director

900 SOUTH FREMONT AVENUE
ALHAMBRA, CALIFORNIA 91803-1331
Telephone: (626) 458-5100
http://dpw.lacounty.gov

ADDRESS ALL CORRESPONDENCE TO:
P.O. BOX 1460
ALHAMBRA, CALIFORNIA 91802-1460


IN REPLY PLEASE
REFER TO FILE: PD-7

May 27, 2009



Mrs. Shonnie Cline, Senior Account Manager
Water Research Foundation
6666 West Quincy Avenue
Denver, CO 80235

Attention TC Proposal Desk

Dear Mrs. Cline:

**COUNTY OF LOS ANGELES DEPARTMENT OF PUBLIC WORKS – WATERWORKS PILOT STUDY OF IN-SITU ARSENIC REMOVAL AND GROUNDWATER RECHARGE IN THE ANTELOPE VALLEY**

Enclosed for your consideration are six hard copies and one digital copy of the application package for the joint study between County of Los Angeles Department of Public Works – Waterworks, a member of the Water Research Foundation, the United States Geological Survey, and Antelope Valley East Kern Water Agency to remove high levels of arsenic in groundwater wells while increasing the amount of water storage in the Antelope Valley

The in-situ arsenic removal project has the potential to provide critical information regarding groundwater management for the entire Antelope Valley In addition, the water quality collection techniques, arsenic mitigation strategies, and water recharge options for this study will be transferable to other utilities addressing high levels of arsenic in their production wells or imported surface water

If you have any questions, please contact Ms. Kathi Delegal, Head of our Grants Management Section, at (626) 458-3912.

Very truly yours,

GAIL FARBER
Director of Public Works

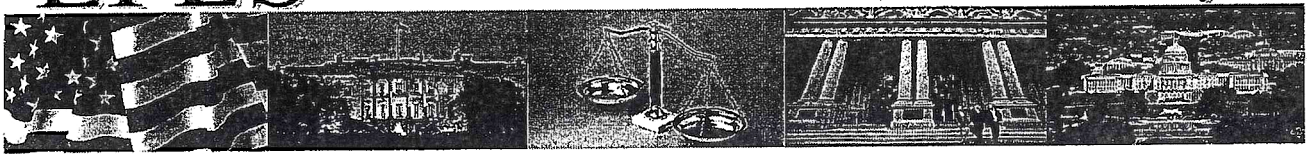
FOR: PATRICK V DeCHELLIS
Deputy Director

LS:sp
C090782
P:\pdpub\Grants\TRANSMITTAL LETTERS\2009\Tailored Collaboration Program 2009.doc

Enc.

EPLS

Excluded Parties List System



**Search - Current Exclusions**

- > Advanced Search
- > Multiple Names
- > Exact Name and SSN/TIN
- > MyEPLS
- > Recent Updates

**View Cause and Treatment Code Descriptions**

- > Reciprocal Codes
- > Procurement Codes
- > Nonprocurement Codes

**Agency & Acronym Information**

- > Agency Contacts
- > Agency Descriptions
- > State/Country Code Descriptions

**OFFICIAL GOVERNMENT USE ONLY**

- > Debar Maintenance
- > Administration
- > Upload Login

**EPLS Search Results**

## Search Results for Parties Excluded by

**Partial Name : DAVID AND PEDERSEN or LOS ANGELES AND COUNTY AND DEPARTMENT or US AND GEOLOGICAL AND SURVEY or ANTELOPE AND VALLEY-EAST AND KERN AND WATER AND AGENCY or T.J. AND KIM**

**As of 11-Jun-2009 3:09 PM EDT**

**Save to MyEPLS**

**Your search returned no results.**

**Back New Search Printer-Friendly**

**Resources**

- > Search Help
- > Public User's Manual
- > FAQ
- > Acronyms
- > Privacy Act Provisions
- > News

**Reports**

- > Advanced Reports
- > Recent Updates
- > Dashboard

**Archive Search - Past Exclusions**

- > Advanced Archive Search
- > Multiple Names
- > Recent Updates

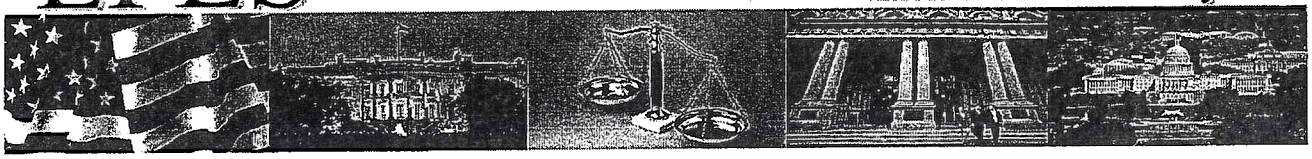
**Contact Information**

- > Email: support@epls.gov
  eplscomments@epls.gov
- > Phone: 1-866-GSA-EPLS
  1-866-472-3757

EXHIBIT A

# EPLS

Excluded Parties List System



**Search - Current Exclusions**

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**View Cause and Treatment Code Descriptions**

> Reciprocal Codes
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**Agency & Acronym Information**

> Agency Contacts
> Agency Descriptions
> State/Country Code Descriptions

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**EPLS Search Results**

## Search Results for Parties Excluded by

**Partial Name : JOHN AND IZBICKI or ADAM AND ARIKI**

**As of 11-Jun-2009 3:12 PM EDT**

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**Resources**

> Search Help
> Public User's Manual
> FAQ
> Acronyms
> Privacy Act Provisions
> News

**Reports**

> Advanced Reports
> Recent Updates
> Dashboard

**Archive Search - Past Exclusions**

> Advanced Archive Search
> Multiple Names
> Recent Updates

**Contact Information**

> Email: support@epls.gov
eplscomments@epls.gov
> Phone: 1-866-GSA-EPLS
1-866-472-3757

EXHIBIT A

**RESPONSE TO WATER RESEARCH FOUNDATION TECHNICAL REVIEW COMMITTEE'S COMMENTS**

The following are responses to the Technical Review Committee's (TRC) review of the Tailored Collaboration Proposal sponsored by LA County DPW The proposal has been modified as needed to address these comments. The authors thank the TRC for their thoughtful comments. We agree with the TRC suggestion that the project obtain approval from the Lahonatan Regional Water Quality Control Board (RWQCB) before beginning. Many of the TRC comments recommending additional analytics and procedural changes will be considered as part of the permit application and incorporated into the study as requested by the RWCQB.

The USGS and LACDPW-WW have been in communication with the RWQCB in order to achieve regulatory approval. The RWQCB is very pleased with the proposal and has given much positive feedback along with their comments and suggestions. They would like to see monitoring of additional constituents to receive long-term regulatory acceptance as well as the necessary permits and environmental documents for the implementation of a pilot scale project to prove that there are adequate mitigation measures in place to protect the ground water basin. LACDPW-WW will comply with the RWQCB's comments and is in the process of putting together the necessary documents. LACDPW-WW and Lahontan RWQCB have agreed that LACDPW-WW will meet all of the requirements of a full scale project and plans to submit draft applications for a Waste Discharge Permit in September 2009 and CEQA documentation in October 2009 in order to complete the regulatory process by the end of 2009

Task 1:--Installation of Borehole

1 Virgin material will be used to backfill the borehole. These materials are intended to optimize the contact between the instrument and the surrounding unsaturated materials. These materials include #60 graded sand for advanced tensiometers, and silica flour for heat-dissipation probes, dielectric permittivity sensors, and suction-cup lysimeters. The materials have been tested in previous studies and have been shown to not contaminate water samples for selected trace elements such as chromium or arsenic. (Despite superior hydraulic performance, the use of diatomeous earth in instrument borehole of this design was discontinued in previous studies because it is a source of chromium.) Additional testing will be done as part of this study to ensure the backfill materials and the ceramic-cup of the lysimeters do not contaminate water samples with arsenic. Backfill materials also include a three part mixture of #3 graded sand, bentonite chips, and bentonite pellets to provide a seal between instruments within the borehole. The #3 sand in the bentonite is intended to provide structural support of the seal in the unsaturated zone. The bentonite will be installed dry In previous studies, repeated neutron logs collected from similar boreholes show the bentonite hydrates and swells within the borehole to complete the seal.

Task 2.—Unsaturated materials

1 The use of the ODEX drilling technique minimizes contamination of the unsaturated zone by drilling fluids and lubricants. The ODEX drilling technique uses air to operate the drill bit and remove cuttings from the hole. Water or other drilling fluids, which would contaminate unsaturated materials, are not used in the drilling process and the borehole is stabilized with a 8-inch diameter steel pipe that is withdrawn as backfill and instruments are installed. The threaded joints on the ODEX pipe are lubricated with biodegradable vegetable oil to ensure contamination from industrial solvents and lubricants does not occur Some compressed air may escape into the unsaturated formation during the drilling process. To minimize air exchange between the surface and the unsaturated zone the top of the steel ODEX pipe is sealed when drilling is not in progress. Atmospheric air that enters the unsaturated zone during the drilling process can be removed by pumping with a peristaltic pump and low-level samples for atmospheric contaminates such as chlorofluorocarbons have been successfully collected from borehole built using this design.

2. Available literature suggests the CaWET test does produce higher arsenic concentrations in leachate than the U.S Environmental Protection Agency Toxicity Characterization Leaching Protocol (TCLP). At the suggestion of the TRC, the proposal (including TRC comments) has been submitted to the Lahontan Regional Water Quality Control Board (RWQCB) for review and permitting as required. We will follow the recommendations of the RWQCB

3 The soils, paleosols, and alluvial materials underlying the proposed site do not contain unusually high concentrations of alumina, iron, and manganese on the surface coatings of mineral grains. Surface coatings of these types are ubiquitous and their abundance is commonly related to particle size because of the increased surface area of fine-grained materials. As a consequence, fine-grained deposits and paleosols, where weathering has produced clay-sized particles, will contain increased abundance of surface coatings compared to coarser-grained material. The abundance of alumina, iron, and manganese surface coatings at the study site will be measured and results compared to other sites in the Mojave Desert and elsewhere where similar data are available to ensure the site is not unusual and is representative of unsaturated alluvial deposits elsewhere in arid areas of the Southwestern United States. Because surface coatings in unsaturated alluvial material are ubiquitous the approach is expected to have widespread application throughout alluvial aquifers in the Southwestern United States. The limiting factor in the transferability of results from this study is not the presence of iron and alumina oxides on soil mineral grains but rather the presence sufficiently thick unsaturated zones and underlying hydrologic conditions—primarily low arsenic groundwater at the water table and high-arsenic groundwater These conditions are present throughout much of the southwestern United States. In California these conditions are present in the eastern San Joaquin Valley, Owen Valley, Indian Wells Valley, the Antelope Valley, and the Mojave and Morongo Groundwater basins.

4 Organic carbon is typically low in alluvial material in arid areas but the organic carbon concentration in alluvial materials will be characterized as as part of this

proposal. Water extractable phosphate and fluoride will be measured as part of this proposal. Antimony will be added to the analyte list if requested by the RWQCB during permitting. Arsenic concentrations will be speciated as part of this study pH, alkalinity, conductivity will be measured routinely on samples from wells and suction-cup lysimeters. Dissolved oxygen and ORP will only be measured on samples of water from wells because collection procedures for water from suction-cup lysimeters precludes these analyses.

Task 3—Laboratory Column Studies

Column Laboratory Prepared Water

1 The use of synthetic water was intended to eliminate unexpected competitive effects from trace elements that may be difficult to quantify It was believed during design of the experiment that control of these effects would simplify interpretation of the data and make it easier to understand and quantify the sorption of arsenic to alluvial materials. The issue of synthetic versus native water for use in the column studies will be posed to the RWQCB for consideration during their permitting process.

2. The native water quality as described in the proposal is alkaline oxic in the upper aquifer and alkaline reducing in the deeper aquifer that will be pumped to supply recharge water to the wells. A table of expected water quality has been added to the proposal. The proposal call for complete chemical analysis including trace element concentrations and arsenic speciation of water supplied to the pond.

3 The computer program UnSatChem will be used to model water flow and chemical reactions in the exchange column. The computer program was developed by Donald Suarez at the U.S. Department of Agriculture Soil Salinity Laboratory in Riverside, Calif. Drs. Suarez and Goldberg at the Soil Salinity Laboratory will do the column studies and chemical modeling included in this proposal.

4. A table of native water quality will be included in the proposal and a description of the proposed synthetic water to be used in the column studies will be included in the proposal

Column Operation

1 The laboratory prepared water will be passed through the column continuously The sample collection apparatus needed for this procedure is available at the Soil Salinity Laboratory

2. CaWET or TCLP analysis of column material will be included pending review comments from the RWQCB

3 The concentrations of alumina, iron, and manganese in native water are not high and are listed in the Table of native water chemistry

4 The infiltration rate of the columns will be a function of the hydraulic properties of the materials selected for column studies. The proposal calls for a range of materials to be tests from coarse-grained material to finer grained materials. The infiltration rates will vary accordingly and are expected to range from 2 ft/d to about 0.25 ft/d. Column lengths will be adjusted if needed to ensure breakthrough curves are adequately characterized.

Desorption

1 We will consult with the RWQCB at part of the permitting process to determine their needs associated with additional desorption experiments. We will add a tracer to the synthetic water to evaluate the movement of water through the columns.

2. Analysis of the sequential extractions for radiolabeled arsenic-73 is intended to determine if arsenic remains sorbed on surface coatings and readily exchangeable therefore highly mobile, or if arsenic is incorporated into minerals on the surface coatings and becomes less mobile over time. This series of experiments is intended to provide comparable information to the desorption experiments requested by the TRC. However, the use of radiolabled arsenic provides greater sensitivity and more information on the fate of arsenic than can be provided from chemical desorption data alone. The timeseries of extraction data will be interpreted to determine if mineralization of arsenic is occurring and (if occurring) to determine the rate of mineralization. These data can be used by managers and regulators to determine when and if alternative land uses that may alter the geochemistry of the site can be permitted. The proposal has been modified to provide additional explanation of the purpose of these experiments.

3 We will consult with the RWQCB at part of the permitting process to determine their needs associated with additional desorption experiments. Additional experiments will be incorporated into the study as required by the RWQCB

4. Additional information has been incorporated into the experiment on the range of conditions to be evaluated as part of the radiolabled arsenic studies.

General Comments

1 The column experiments do provide a range of information and data on the sorptive behavior of arsenic on unsaturated materials for an apparent low cost. However, a field demonstration of the proposed treatment technique is ultimately required. In addition, it would not be possible to do the column studies without the unsaturated materials obtained from test drilling. So the true cost of the laboratory column studies included the drilling costs associated with obtaining the materials. When viewed in this light, although additional laboratory column studies may be desirable and may be required by permitting by the RWQCB, additional column studies do not provide an opportunity to reduce the cost of the proposal.

2 The pH range to be used in this study reflects the range of pH's expected to be encountered in native groundwater and unsaturated zone water found at the site. The range is not unusual for arid areas.

3 During the design of the proposal the concern was the opposite—that we would not see arsenic breakthrough during the column experiments because arsenic is so strongly sorbed on these types of marterials. We will adjust column lengths if necessary to ensure an adequate characterization of arsenic breakthrough.

Task 4—Data Collection from the Borehole

1 Part of the field experiment is to determine the effect of wetting on the unsaturated materials on arsenic sorption. The combination of carefully

constrained laboratory column experiments coupled with interpretation of results from a large-scale field experiment provides the opportunity to test the validity of laboratory derived information on sorption kinetics for different materials using data from the field study. Interpretation of chemical and hydraulic data the field study is intended to allow separation of sorptive effects from advective and storage effects within the unsaturated zone.

2. Previous studies show clogging of the unsaturated zone occurs at the pond bottom. This clogging requires periodic maintenance and removal of fines to keep infiltration rates high. Clogging by particulates at deeper depths is not expected to be an issue as indicated by the long-term recharge of water by infiltration from ponds at sites throughout California

3 The water quality of the proposed high-arsenic recharge water will be provided in a table in the proposal and will be measured during the study The water quality of water as it infiltrates through the unsaturated zone will be measured as part of the study

4 The source water quality and pond water quality will be monitored as part of the study

Task 5—Evaluation of Experimental Performance

1 The backfill materials are described in Task 1, Bullet 1 and in the proposal has been modified to include the additional information. Material will be installed from the surface. The fine-grained mature of the material and instruments within the borehole preclude the use of a tremmie pipe to install the material. Using established procedures the material will be frequently sounded as it is placed in the borehole to ensure adequate filling and to ensure the ODEX pipe does not "sand-lock" during installation. Backfill material will extend above the target depths to allow for settling within the borehole after installation. To date more than 20 instrumented borehole have been successfully installed based on this design without the use of a tremmie pipe.

2. Yes. As the reviewers have indicated there is possibility that the laboratory data collected using a synthetic water will differ from field results collected using native water Trace elements that may interfere with arsenic sorption will be evaluated as part of this section.

3. We agree, and sample collection from the pond bottom before and after recharge has already been included in the proposal as part of the experimental design.

Task 6—Report Preparation

1. Yes. The UnsatChem model results developed as part of laboratory work done as part of this proposal will be compared to TOUGH2 model results from an associated project evaluating the site for large scale recharge. TOUGH2 is capable of simulating variably saturated flow and transport in 3-dimensions and model results will serve as a base line to evaluate departures of field data from behavior expected on the basis of laboratory results.

Application Potential

1 As discussed in Task 2, Bullet 3 the soils, paleosols, and alluvial material at the site are not unusual. The alumina, iron, and manganese oxide surface coatings that

provide the sorption sites for arsenic are naturally occurring and ubiquitous on mineral grains everywhere. The presence of sufficient oxides to sorb arsenic is a function of particle-size distribution of the deposits. Sites that have finer-grained material with sufficient oxides for sorption expected at this site are not normally considered for artificial recharge because of their lower infiltration rates compared to coarser-grained sites. Otherwise, there is nothing unique about the surface chemistry of materials at the proposed study site and similar materials are abundant in alluvial aquifers throughout the arid Southwestern United States. We have taken the TRC's advice and are preparing a permit application to recharge high-arsenic at the site. This will allow regulatory agencies the opportunity to determine regulatory requirements for this type of activity

1,2, and 3 As previously stated, we have taken the TRC's advice and are preparing a permit application to recharge high-arsenic at the site. This will allow regulatory agencies the opportunity to determine regulatory requirements for this type of activity

4. California Department of Health Services oversees the recharge and reuse of reclaimed municipal wastewater and will not regulate this work. The regulatory requirements outlined by the TRC are in excess of what is normally required for the reuse of reclaimed wastewater as the Department of Health Services normally requires a 6 month residence time for the reuse of reclaimed water

5 The proposal is intended to strike a balance between a field-scale demonstration experiment and laboratory work with the use of numerical models to integrate the results of field and laboratory work. The permit process through the RWQCB, as suggested by the TRC, will further refine this balance and produce a product suitable for scientific, management, and regulatory purposes. Information and regulatory requirements dictated by the RWQCB may dictate the order in which some tasks are done.

Budget

1 The funds allocated for report preparation include data interpretation and analysis and report review which can be extensive for a project of this type. The proposal has been modified to reflect these changes.

2. LACDPW WW will further look into cost savings regarding project management.

EXHIBIT A

# Communication Plan for In-Situ Arsenic Removal in Antelope Valley

**Target Audiences and end users of project results:**
Utilities (90% of Water Research Foundation's subscribers), with emphasis on utilities in the Southwest U.S.
Consultants and Manufacturers
General Public
Policy makers

**Deliverables and Communication Timing:**
At project signing:

- 1 page fact sheet focusing on project overview, suitable for all adult audiences but specifically to generate interest by utilities, water mangers, and professionals
- Press release with project overview and study goals suitable for press and general public.

Early project:

- Website containing project overview and updates including real-time progress of arsenic concentrations as the water moves through the unsaturated alluvium. Also includes descriptions of interesting scientific processes. Can have several levels of detail with more detail available with links for interested parties.

Throughout project

- Speaking engagements discussing current project work, findings and project overview with content presentation at professional level for events such as
  - Association of California Water Agency (ACWA) May and December conferences
  - National Groundwater Association meetings
  - Water Education Foundation tours
- LACWWD and/or USGS will submit project abstracts and findings for consideration to present at AWWA CA-NV section meeting and/or the AWWA Annual Conference
- Project overview, high level, brief article in ACWA newsletter – to coincide with December or May conference.
- Possible engagement of Steve Wessells, USGS videographer, to do short video on this study in conjunction with a drilling video he is planning. This would be for general interest – low detail level.

End of Project:

- Podcast giving results overview and future use of arsenic removal approach intended to inform general public.
- Press release with study results when final report is published for all audiences.
- Fact sheet providing study results and describing future use of approach. For utilities water managers, consultants, manufacturers and general public.

**Opportunities for joint communication activities with other ongoing projects or with other trade or professional organizations:**

- Water Education Foundation tour speaking engagements (as noted above)
- Possible "Water in the Desert" publication with Water Education Foundation with emphasis on water-quality remediation.
- Consolidated fact sheet describing techniques to monitor artificial recharge and arsenic remediation completed by the USGS throughout the southwestern U.S

**Exhibit B**
**Project 04299**

**Title: In-Situ Arsenic Removal on Unsaturated Alluvium**

| TASK | DUE DATE |
|---|---|
| Begin Project | May 15, 2010 |
| Scope of Work | June 15, 2010 |
| Participant presents Proof of Insurance(s) or Certificate of Self Insurance & Worker's Compensation Insurance | June 15, 2010 |
| Periodic Report 1 & Invoice | August 15, 2010 |
| Periodic Report 2 (incl. Technical Summary & Web Update) & Invoice | November 15, 2010 |
| Periodic Report 3 & Invoice | February 15, 2011 |
| Periodic Report 4 (incl. Technical Summary & Web Update) & Invoice | May 15, 2011 |
| Periodic Report 5 & Invoice | August 15, 2011 |
| Periodic Report 6 (incl. Technical Summary & Web Update) & Invoice | November 15, 2011 |
| Periodic Report 7 & Invoice | February 15, 2012 |
| Periodic Report 8 (incl. Technical Summary & Web Update) & Invoice | May 15, 2012 |
| Periodic Report 9 & Invoice | August 15, 2012 |
| Periodic Report 10 (incl. Technical Summary & Web Update) & Invoice | November 15, 2012 |
| Periodic Report 11 & Invoice | February 15, 2013 |
| Draft Report & Invoice | April 15, 2013 |
| Final Report & Final Compensation | September 15, 2013 |
| Letters of Confirmation for participating utilities | September 15, 2013 |
| Complete & Submit Exhibit E – Assignment of Copyright | September 15, 2013 |
| Project End & Foundation Publication Date | April 15, 2014 |

**Note: Final payment will be disbursed subsequent to PI's response to editor queries on the final report, as defined in the Foundation's "Tailored Collaboration Guidelines," and submission of a final invoice detailing final Project costs including cost share and in-kind contributions. Please submit one electronic copy of each Periodic Report, Draft & Final Report in MSWord format. For each report an invoice must be submitted for payment using Exhibit D – printed on your company letterhead.**

**BUDGET SUMMARY**

**Exhibit C**
**04299**

WATER RESEARCH FOUNDATION
ADVANCING THE SCIENCE OF WATER

Contractor: Los Angeles County DPW-Waterworks District
900 South Fremont Avenue
Alhambra, CA 91803-1331

| ORGANIZATION | Award Amount | Cost Share | In-Kind Amount |
|---|---|---|---|
| **Co-funders** | | | |
| Los Angeles County DPW-Waterworks District | $438,000 * | $0.00 | $0.00 |
| **Sub-recipient** | | | |
| Los Angeles County DPW-Waterworks District | $0.00 | $95,472 | $0.00 |
| **Participants** | | | |
| US Geological Survey | $0.00 | $134,992 | $0.00 |
| Antelope Valley East Kern Water District | $0.00 | $0.00 | $180,000 |
| **Water Research Foundation** | $150,000 | $0.00 | $0.00 |
| **TOTALS** | **$588,000** | **$230,464** | **$180,000** |
| **Total Project Budget $998,464** | | | |

***Note** – LACDPW total cash contribution will be managed by LACDPW and will be paid into the Project before the Foundation's funds are spent. LACDPW will be responsible for managing and reporting the expenditure of these funds per the invoice reporting schedule outlined in Exhibit B. LACDPW cash contribution will be allocated toward the matching funds requirement of $300,000 toward the Foundation and $138,000 toward USGS.

**Award Amount: $588,000**
**Amount due upon acceptance of draft report: $58,800**
**Amount due upon acceptance of final report and final invoice: $58,800**
**No Project Advance:**

**Title: In-Situ Arsenic Removal on Unsaturated Alluvium**

**Exhibit D – Invoice Form**

For access to the Water Research Foundation website please see:
*http://www.waterresearchfoundation.org*

To download Exhibit D – Invoice Form please see:
*http://www.waterresearchfoundation.org/research/projectAdmin/contractsAndForms.aspx*

The invoice form was created under MS Excel and is a protected worksheet. Please fill in the yellow highlighted areas.

**Exhibit E**
**Project 04299**

**Title: In-Situ Arsenic Removal on Unsaturated Alluvium**

## Assignment of Copyright

Whereas _____, whose address is _____ ["Assignor"] has created and authored an original expression of an idea and/or design described as follows:

_____ (hereafter the "Work"); and

The Assignor claims and warrants exclusive ownership, with no transfers having occurred prior to this Assignment, of all right, title and interest in and to the Work, including the copyright.

Whereas Water Research Foundation, whose principal place of business is located at 6666 W Quincy Avenue, Denver, Colorado 80235 U.S.A. ["Assignee"], is desirous of obtaining all rights, title and interest in and to the Work, including the copyright.

NOW, THEREFORE, for good and valuable consideration, receipt of which is hereby acknowledged, said Assignor does hereby assign unto the said Assignee all world-wide right, title and interest in and to the said Work, including the right to apply for copyright for that Work as sole Owner

_____
Signature of Assignor Date

State of _____}
}ss.
County of _____ }

On this _____ day of _____, 20____ before me appeared _____ _____, the person who signed this instrument, who acknowledged that he/she Signed it as a free act on his/her own behalf (or on behalf of the identified corporation or other Juristic entity with authority to do so).

_____
Notary Public Comm'n. Exp.

**ENCLOSURE C**

**INITIAL STUDY OF ENVIRONMENTAL FACTORS**

**COUNTY OF LOS ANGELES**
**DEPARTMENT OF PUBLIC WORKS**
**LOS ANGELES COUNTY WATERWORKS**
**DISTRICT NO. 40, ANTELOPE VALLEY**
**REGION 4, LANCASTER**

**IN-SITU ARSENIC REMOVAL ON UNSATURATED ALLUVIUM**

1 Project Title

In-Situ Arsenic Removal on Unsaturated Alluvium

2 Lead Agency Name and Address

Los Angeles County Department of Public Works
Waterworks Division
P.O. Box 1460
Alhambra, CA 91802-1460

3 Contact Person and Phone Number

Mr Clark Ajwani · (626) 300-4687

4 Project Location

The proposed project site is in the northwestern part of the Lancaster subbasin, north of the Antelope Buttes, approximately 16 miles northwest of Lancaster, California. The site is at Avenue B-8 and 155th Street West in Willow Springs, California. The approximate latitude and longitude of the site is 34 797427 and ·118 405283, respectively

5 Project Sponsors Name and Address

Los Angeles County Department of Public Works
Waterworks Division
P.O. Box 1460
Alhambra, CA 91802-1460

6 General Plan Designation

Nonurban uses

7 Zoning

A-2 Heavy Agricultural

8 Description of Project

The purpose of this project is to determine the effectiveness and sustainability of naturally occurring alumina, iron, and manganese oxides in the unsaturated zone to treat high-arsenic water Results of the study will be used to develop a methodology to transfer the technique to areas having high-arsenic water

Water containing arsenic concentration of about 30 micrograms per liter (µg/L) will be pumped from deeper aquifers and infiltrated into a 1-acre pond. Arsenic in the infiltrated water is expected to be sorbed on naturally occurring alumina and iron oxides in soil and the water will recharge the shallow aquifer having arsenic concentrations of about 1 µg/L The movement of water and effectiveness of naturally occurring alumina, iron, and manganese oxides in the unsaturated zone to sorb arsenic will be monitored using data from an instrumented borehole installed at the site Arsenic concentrations and toxicity of unsaturated materials will be determined before and after the infiltration as part of this study Laboratory column experiments will be done on samples of unsaturated alluvium to evaluate the physical and chemical factors that control sorption of arsenic under different geochemical conditions. Laboratory batch experiments will be done using radiolabled arsenic-73 to determine the long-term fate of sorbed arsenic and its potential mobility

9 Surrounding Land Uses and Environmental Setting

The proposed treatment site consists of 1 acre within about 1,500 acres of land owned by the Antelope Valley-East Kern Water Agency Most of the land is undeveloped open space with agriculture areas Historically, the site has been used for agricultural purposes, primarily row crops and alfalfa. In 2008, the water table was about 250 feet below land surface in the eastern part of the project area. The unsaturated alluvial deposits at the site consist of interbedded heterogeneous mixtures of silt, sand, and gravel. Given the depositional environment, unsaturated alluvium is expected to contain paleosols having sufficient alumina, iron, and manganese oxide development to sorb arsenic in water infiltrated from ponds

10 Other public agencies whose approval is required (e.g., permits, financial approval, or participation agreement.)

- Antelope Valley-East Kern Water Agency
- Lahontan Regional Water Quality Control Board – Waste Discharge Requirements

## ENVIRONMENTAL FACTORS POTENTIALLY AFFECTED

The environmental factors checked below would be potentially affected by this project, involving at least one impact that is a "Potentially Significant Impact" as indicated by the checklist on the following pages

| | | |
|---|---|---|
| ___ Aesthetics | ___ Agriculture Resources | ___ Air Quality |
| ___ Biological Resources | ___ Cultural Resources | ___ Geology/Soils |
| ___ Hazards & Hazardous Materials | ___ Hydrology/Water Quality | ___ Land Use/Planning |
| ___ Mineral Resources | ___ Noise | ___ Population/Housing |
| ___ Public Services | ___ Recreation | ___ Transportation / Traffic |
| ___ Utilities/Service Systems | ___ Mandatory Findings of Significance | |

DETERMINATION: (To be completed by the Lead Agency)

On the basis of this initial evaluation:

_X_ I find that the proposed project COULD NOT have a significant effect on the environment, and a NEGATIVE DECLARATION will be prepared

____ I find that although the proposed project could have a significant effect on the environment, there will not be a significant effect in this case because revisions in the project have been made by or agreed to by the project proponent. A MITIGATED NEGATIVE DECLARATION will be prepared.

____ I find that the proposed project MAY have a significant effect on the environment, and an ENVIRONMENTAL IMPACT REPORT is required.

____ I find that the proposed project MAY have a "potentially significant impact" or "potentially significant unless mitigated" impact on the environment, but at least one effect 1) has been adequately analyzed in an earlier document pursuant to applicable legal standards, and 2) has been addressed by mitigation measures based on the earlier analysis as described on attached sheets. An ENVIRONMENTAL IMPACT REPORT is required, but it must analyze only the effects that remain to be addressed.

____ I find that although the proposed project would have a significant effect on the environment, because all potentially significant effects (a) have been analyzed adequately in an earlier ENVIRONMENTAL IMPACT REPORT or NEGATIVE DECLARATION pursuant to applicable standards, and (b) have been avoided or mitigated pursuant to that earlier ENVIRONMENTAL IMPACT REPORT or NEGATIVE DECLARATION, including revisions or mitigation measures that are imposed upon the proposed project, nothing further is required

_____ _____

Signature Date

_____ _____

Printed Name For

# PROPOSED NEGATIVE DECLARATION

## COUNTY OF LOS ANGELES
## DEPARTMENT OF PUBLIC WORKS
## LOS ANGELES COUNTY WATERWORKS
## DISTRICT NO. 40, ANTELOPE VALLEY
## REGION 4, LANCASTER

## IN-SITU ARSENIC REMOVAL ON UNSATURATED ALLUVIUM

I. Location and Brief Description

The proposed treatment site is in the northwestern part of the Lancaster subbasin, north of the Antelope Buttes, approximately 16 miles northwest of Lancaster, California (Figure 1). Approximately 1 acre of about 1,500 acres will be used for this work at Avenue B-8 and 155th Street West in Willow Springs, California (Figure 2). The approximate latitude and longitude of the site is 34.797427 and -118.405283, respectively

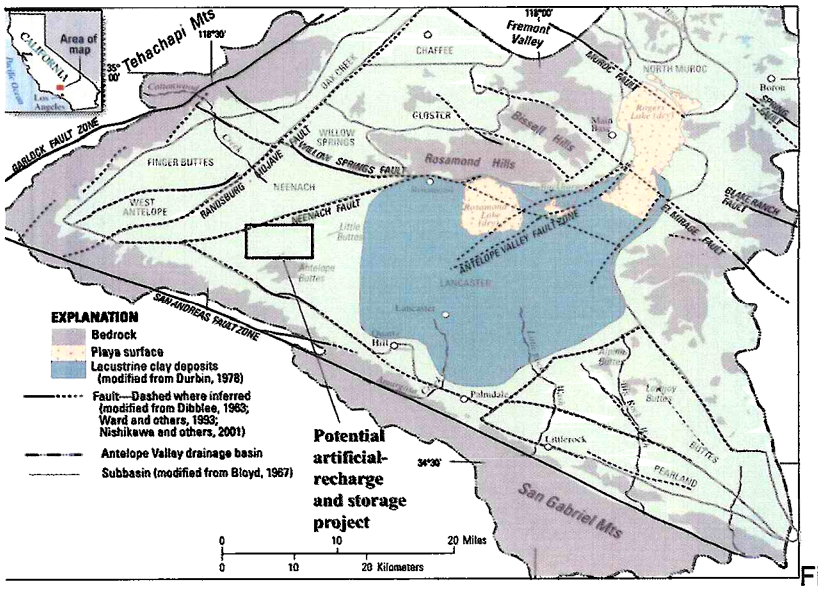

Figure 1.—Study area location

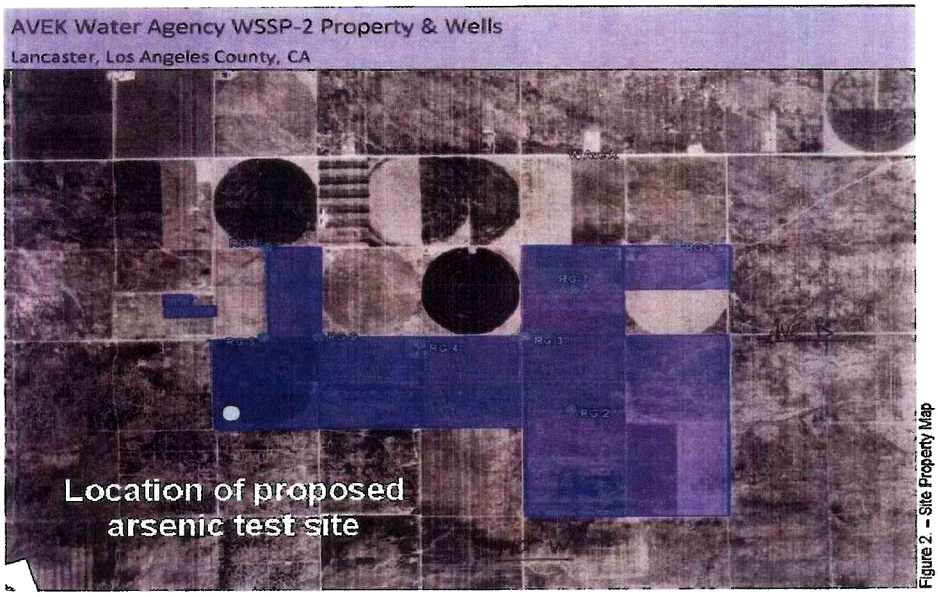


Figure 2 – Site Property Map

The purpose of this project is to determine the effectiveness and sustainability of naturally occurring alumina, iron, and manganese oxides in the unsaturated zone to treat high-arsenic water Results of the study will be used to develop a methodology to transfer the technique to areas having high-arsenic water

Water containing arsenic concentration of about 30 micrograms per liter (µg/L) will be pumped from deeper aquifers and infiltrated into a 1-acre pond Arsenic in the infiltrated water is expected to be sorbed on naturally occurring alumina and iron oxides in soil and the water will recharge the shallow aquifer having arsenic concentrations of about 1 µg/L.

II Mitigation Measures Included in the Project to Avoid Potentially Significant Effects

No mitigation measures are included as no significant negative impacts on the environment were identified.

High-arsenic groundwater is already applied to the land as part of agricultural operation at the site. The rate of application and subsequent infiltration to the water table will increase as part of this work. As a precautionary measure, we will (1) monitor at shallow depths to ensure that arsenic is being rapidly removed as planned and (2) monitor at the water table to ensure water actually recharged is low in arsenic. If arsenic removal does not occur as planned, we will know long before the water reaches the water table. In the worst case scenario, if there is no arsenic removal, we will stop the experiment before the water infiltrates to more than 100 feet below land surface. Background arsenic concentrations range from 29 µg/L to 4 µg/L. We chose the lowest concentration of 4 µg/L as the threshold concentration at 100 feet below land surface, where pumping will stop if that concentration is exceeded Groundwater modeling was done using TOUGH2 assuming the same lithology as the nearby Antelope Valley-East Kern Water Agency agricultural well RG-3 and an infiltration

rate of 0.55 acre feet per day A 1-acre circular pond was used and after 3 months, infiltration was stopped where the wetting front reached 100 feet. After 4 months, the infiltrated water perched on a clay layer and would not infiltrate vertically any further Modeling results show that the small amount of water recharged at this decision milestone (about 120 days) would not infiltrate to the water table during the 180-month (15-year) simulation period. In the absolute worst case scenario, only 66 acre feet of water would be infiltrated. If that small amount of water ever reaches the water table, dilution with native water or dilution with water infiltrated elsewhere on the property (anticipated to be about 30,000 acre feet per year) would render the increase in arsenic concentrations associated with the experiment at the water table beneath the site insignificant (and immeasurable).

III. Finding of No Significant Effect

During the experiment, arsenic at the proposed site is expected to be sorbed primarily on iron manganese and alumina oxide sorption sites in the near surface alluvium. The sorption sites in the deeper alluvium provide a tremendous removal capability that is expected to require many decades to saturate. The expected concentration of arsenic entering the groundwater of the shallow aquifer is <1 µg/L.

During a previous artificial recharge experiment along the Oro Grande Wash in the Mojave Desert, arsenic in groundwater pumped into a recharge pond was rapidly sorbed as the water infiltrated through the unsaturated zone. This sorption was on naturally occurring alumina, iron, and manganese oxides present on the surfaces of mineral grains in soil. These oxides are similar to those used in commercial resins. During the experiment, the upper 20 feet of unsaturated material underlying the pond lowered arsenic concentrations in 1,050 acre feet of water infiltrated at the site from 10 µg/L to less than 1 µg/L. As water from the Oro Grande recharge pond infiltrated to greater depths, the amount of lateral spreading from the pond increased. The 1-acre pond had an average wetted footprint in the unsaturated zone of about 30 acres (Izbicki and others, 2008a). Assuming similar sorptive capacity and a similar amount of lateral spreading within the unsaturated zone beneath the Antelope Valley, the total volume of unsaturated material encountered by water infiltrated from a 1-acre pond could treat 100,000 acre feet of water Assuming an average infiltration rate of 2 feet/day through the bottom of the pond, 450 gallons/minute of water could be treated using this approach for more than 100 years before the sorptive capacity of a 300-foot-thick unsaturated zone would be exhausted. The project will demonstrate the effectiveness of in-situ remediation of arsenic and will treat an estimated 3,200 acre feet of groundwater having high arsenic concentrations.

## EVALUATION OF ENVIRONMENTAL IMPACTS

## IN-SITU ARSENIC REMOVAL ON UNSATURATED ALLUVIUM

1) A brief explanation is required for all answers except "No Impact" answers that are adequately supported by the information sources a lead agency cites in the parentheses following each question. A "No Impact" answer is adequately supported if the referenced information sources show that the impact simply does not apply to projects like the one involved (e.g., the project falls outside a fault rupture zone). A "No Impact" answer should be explained where it is based on project specific factors as well as general standards (e.g., the project will not expose sensitive receptors to pollutants based on a project specific screening analysis).

2) All answers must take account of the whole action involved, including off-site as well as on-site, cumulative as well as project level, indirect as well as direct, and construction as well as operational impacts.

3) "Potential Significant Impact" is appropriate if an effect is significant or potentially significant, or if the lead agency lacks information to make a finding of insignificance. If there are one or more "Potential Significant Impact" entries when the determination is made, an Environmental Impact Report is required.

4) "Less Than Significant With Mitigation Incorporation" applies where the incorporation of mitigation measures has reduced an effect from "Potential Significant Impact" to a "Less Than Significant Impact." The lead agency must describe the mitigation measures and briefly explain how they reduce the effect to a less than significant level (mitigation measures from Section XVIII, "Earlier Analysis," may be cross-referenced).

5) Earlier analyses may be used where, pursuant to the tiering, program Environmental Impact Report, or other California Environmental Quality Act process, an effect has been adequately analyzed in an earlier Environmental Impact Report or Negative Declaration. Section 15063(c)(3)(D). Earlier analyses are discussed in Section XVIII at the end of the checklist.

6) Lead agencies are encouraged to incorporate into the checklist references to information sources for potential impacts (e.g., general plans, zoning ordinances). See the sample question below. A source list should be attached and other sources used or individuals contacted should be cited in the discussion.

ENVIRONMENTAL CHECKLIST FORM

# IN-SITU ARSENIC REMOVAL ON UNSATURATED ALLUVIUM

| | | | Potential Significant Impact | Less Than Significant With Mitigation Incorporation | Less Than Significant Impact | No Impact |
|---|---|---|---|---|---|---|
| **I.** | **AESTHETICS - Would the project:** | | | | | |
| | a) | Have a substantial adverse effect on a scenic vista? | | | | X |
| | b) | Substantially damage scenic resources, including, but not limited to, trees, rock outcrops, and historic buildings within a State scenic highway? | | | | X |
| | c) | Substantially degrade the existing visual character or quality of the site and its surroundings? | | | | X |
| | d) | Create a new source of substantial light or glare which would adversely affect day or nighttime views in the area? | | | | X |
| **II.** | **AGRICULTURE RESOURCES - In determining whether impacts to agricultural resources are significant environmental effects, lead agencies may refer to the California Agricultural Land Evaluation and Site Assessment Model (1997) prepared by the California Department of Conservation as an optional model to use in assessing impacts on agriculture and farmland. Would the project:** | | | | | |
| | a) | Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to nonagricultural use? | | | X | |
| | b) | Conflict with existing zoning for agricultural use or a Williamson Act contract? | | | | X |
| | c) | Involve other changes in the existing environment which, due to their location or nature, could result in conversion of Farmland to nonagricultural use? | | | | X |
| **III.** | **AIR QUALITY - Where available, the significance criteria established by the applicable air quality management or air pollution control district may be relied upon to make the following determinations. Would the project:** | | | | | |
| | a) | Conflict with or obstruct implementation of the applicable air quality plan? | | | X | |
| | b) | Violate any air quality standard or contribute substantially to an existing or projected air quality violation? | | | X | |
| | c) | Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable Federal or State ambient air quality standard (including releasing emissions which exceed quantitative thresholds for zone precursors)? | | | X | |
| | d) | Expose sensitive receptors to substantial pollutant concentrations? | | | X | |
| | e) | Create objectionable odors affecting a substantial number of people? | | | | X |
| **IV** | **BIOLOGICAL RESOURCES - Would the project:** | | | | | |

| | | | Potential Significant Impact | Less Than Significant With Mitigation Incorporation | Less Than Significant Impact | No Impact |
|---|---|---|---|---|---|---|
| | a) | Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U S. Fish and Wildlife Service? | | | X | |
| | b) | Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations or by the California Department of Fish and Game or U.S. Fish and Wildlife Service? | | | | X |
| | c) | Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means? | | | | X |
| | d) | Interfere substantially with the movement of any native resident, migratory fish, or wildlife species, or with established native resident or migratory wildlife corridors; or impede the use of native wildlife nursery sites? | | | X | |
| | e) | Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance? | | | | X |
| | f) | Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or State habitat conservation plan? | | | | X |
| **V.** | **CULTURAL RESOURCES - Would the project:** | | | | | |
| | a) | Cause a substantial adverse change in the significance of a historical resource as defined in Section 15064.5? | | | | X |
| | b) | Cause a substantial adverse change in the significance of an archaeological resource pursuant to Section 15064 5? | | | | X |
| | c) | Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature? | | | | X |
| | d) | Disturb any human remains, including those interred outside of formal cemeteries? | | | X | |
| **VI.** | **GEOLOGY AND SOILS - Would the project:** | | | | | |
| | a) | Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving: | | | | |
| | | i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State geologist for the area or based on other substantial evidence of a know fault? Refer to Division of Mines and Geology Special Publication 42. | | | | X |

| | | | Potential Significant Impact | Less Than Significant With Mitigation Incorporation | Less Than Significant Impact | No Impact |
|---|---|---|---|---|---|---|
| | | ii) Strong seismic ground shaking? | | | | X |
| | | iii) Seismic-related ground failure, including liquefaction? | | | | X |
| | | iv) Landslides? | | | | X |
| | b) | Result in substantial soil erosion or the loss of topsoil? | | | | X |
| | c) | Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse? | | | | X |
| | d) | Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property? | | | | X |
| | e) | Have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater? | | | | X |
| **VII.** | **HAZARDS AND HAZARDOUS MATERIALS - Would the project:** | | | | | |
| | a) | Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials? | | | | X |
| | b) | Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment? | | | | X |
| | c) | Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school? | | | | X |
| | d) | Be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code, Section 65962.5, and, as a result, would it create a significant hazard to the public or the environment? | | | | X |
| | e) | For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project result in a safety hazard for people residing or working in the project area? | | | | X |
| | f) | For a project within the vicinity of a private airstrip, would the project result in a safety hazard for people residing or working in the project area? | | | | X |
| | g) | Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan? | | | | X |
| | h) | Expose people or structures to a significant risk of loss, injury, or death involving wild land fires, including where wild lands are adjacent to urbanized areas or where residences are intermixed with wild lands? | | | | X |

| | | | Potential Significant Impact | Less Than Significant With Mitigation Incorporation | Less Than Significant Impact | No Impact |
|---|---|---|---|---|---|---|
| | i) | Generate vectors (flies, mosquitoes, rodents, etc.) or have a component that includes agricultural waste. Specifically, exceed the following qualitative threshold: (a) occur as immature stages and adults in numbers considerably in excess of those found in the surrounding environment; (b) are associated with design, layout, and management of project operations, (c) disseminate widely from the property; and (d) cause detrimental effects on the public health or well being of the majority of the surrounding population. | | | X | |
| **VIII.** | **HYDROLOGY AND WATER QUALITY - Would the project:** | | | | | |
| | a) | Violate any water quality standards or waste discharge requirements? | | | X | |
| | b) | Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of preexisting nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted)? | | | | X |
| | c) | Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off-site? | | | | X |
| | d) | Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site? | | | | X |
| | e) | Create or contribute runoff water which would exceed the capacity of existing or planned storm water drainage systems or provide substantial additional sources of polluted runoff? | | | | X |
| | f) | Otherwise substantially degrade water quality? | | | X | |
| | g) | Place housing within a 100-year flood hazard area as mapped on a Federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map? | | | | X |
| | h) | Place within a 100-year flood hazard area structures which would impede or redirect flood flows? | | | | X |
| | i) | Expose people or structures to a significant risk of loss, injury, or death involving flooding, including flooding as a result of the failure of a levee or dam? | | | X | |
| | j) | Inundation by seiche, tsunami, or mudflow? | | | | X |
| **IX.** | **LAND USE AND PLANNING - Would the project:** | | | | | |
| | a) | Physically divide an established community? | | | | X |

| | | | Potential Significant Impact | Less Than Significant With Mitigation Incorporation | Less Than Significant Impact | No Impact |
|---|---|---|---|---|---|---|
| | b) | Conflict with any applicable land use plan, policy, or regulation of any agency with jurisdiction over the project (including, but not limited to, the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect? | | | | X |
| | c) | Conflict with any applicable habitat conservation plan or natural community conservation plan? | | | | X |
| **X.** | **MINERAL RESOURCES - Would the project:** | | | | | |
| | a) | Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the State? | | | | X |
| | b) | Result in the loss of availability of a locally important mineral resource recovery site delineated on a local general plan, specific plan, or other land use plan? | | | | X |
| **XI.** | **NOISE - Would the project result in:** | | | | | |
| | a) | Exposure of persons to or generation of noise levels in excess of standards established in the local general plan or ordinance or applicable standards of other agencies? | | | X | |
| | b) | Exposure of persons to or generation of excessive ground borne vibration or ground borne noise levels? | | | | X |
| | c) | A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project? | | | | X |
| | d) | A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project? | | | X | |
| | e) | For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels? | | | | X |
| | f) | For a project within the vicinity of a private airstrip, would the project expose people residing or working in the project area to excessive noise levels? | | | | X |
| **XII.** | **POPULATION AND HOUSING - Would the project:** | | | | | |
| | a) | Induce substantial population growth in an area, either directly (e.g., by proposing new homes and businesses) or indirectly (e.g., through extension of roads or other infrastructure)? | | | | X |
| | b) | Displace substantial numbers of existing housing, necessitating the construction of replacement housing elsewhere? | | | | X |
| | c) | Displace substantial numbers of people, necessitating the construction of replacement housing elsewhere? | | | | X |
| | d) | Result in a substantial unbalanced or disproportional distribution of impacts of any type on a disadvantaged demographic, such as concentration of toxic emissions | | | | X |

| | | | Potential Significant Impact | Less Than Significant With Mitigation Incorporation | Less Than Significant Impact | No Impact |
|---|---|---|---|---|---|---|
| | | in an area of low income families versus high income families? | | | | |
| **XIII. PUBLIC SERVICES** | | | | | | |
| | a) | Would the project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities; the construction of which could cause significant environmental impacts in order to maintain acceptable service ratios, response times, or other performance objectives for any of the public services: | | | | |
| | | Fire protection? | | | | X |
| | | Police protection? | | | | X |
| | | Schools? | | | | X |
| | | Parks? | | | | X |
| | | Other public facilities? | | | | X |
| **XIV. RECREATION** | | | | | | |
| | a) | Would the project increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated? | | | | X |
| | b) | Does the project include recreational facilities or require the construction or expansion of recreational facilities which might have an adverse physical effect on the environment? | | | | X |
| | c) | Substantially reduce recreational opportunities or substantially degrade recreational experiences? | | | | X |
| **XV. TRANSPORTATION/TRAFFIC - Would the project:** | | | | | | |
| | a) | Cause an increase in traffic which is substantial in relation to the existing traffic load and capacity of the street system (i.e., result in a substantial increase in either the number of vehicle trips, the volume to capacity ratio on roads, or congestion at intersections)? | | | X | |
| | b) | Exceed, either individually or cumulatively, a level of service standard established by the County Congestion Management Agency for designated roads or highways? | | | | X |
| | c) | Result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that results in substantial safety risks? | | | | X |
| | d) | Substantially increase hazards due to a design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)? | | | | X |
| | e) | Result in inadequate emergency access? | | | | X |
| | f) | Result in inadequate parking capacity? | | | | X |

| | | | Potential Significant Impact | Less Than Significant With Mitigation Incorporation | Less Than Significant Impact | No Impact |
|---|---|---|---|---|---|---|
| | g) | Conflict with adopted policies, plans, or programs supporting alternative transportation (e g., bus turnouts, bicycle racks)? | | | | X |
| **XVI.** | **UTILITIES AND SERVICE SYSTEMS - Would the project:** | | | | | |
| | a) | Exceed wastewater treatment requirements of the applicable Regional Water Quality Control Board? | | | | X |
| | b) | Require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects? | | | | X |
| | c) | Require or result in the construction of new storm water drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects? | | | | X |
| | d) | Have sufficient water supplies available to serve the project from existing entitlements and resources, or are new or expanded entitlements needed? | | | | X |
| | e) | Result in a determination by the wastewater treatment provider, which serves or may serve the project, that it has adequate capacity to serve the project's projected demand in addition to the provider's existing commitments? | | | | X |
| | f) | Be served by a landfill with sufficient permitted capacity to accommodate the project's solid waste disposal needs? | | | | X |
| | g) | Comply with Federal, State, and local statutes and regulations related to solid waste? | | | | X |
| **XVII.** | **MANDATORY FINDINGS OF SIGNIFICANCE** | | | | | |
| | a) | Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal, or eliminate important examples of the major periods of California history or prehistory? | | | | X |
| | b) | Does the project have impacts that are individually limited, but cumulatively considerable? ("Cumulatively considerable" means that the incremental effects of a project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects.) | | | | X |
| | c) | Does the project have environmental effects which will cause substantial adverse effects on human beings either directly or indirectly? | | | X | |

## DISCUSSION OF ENVIRONMENTAL FACTORS

## IN-SITU ARSENIC REMOVAL ON UNSATURATED ALLUVIUM

I. AESTHETICS - Would the project:

a) **Have a substantial adverse effect on a scenic vista?**

**No impact.** There will be nothing to produce a substantial adverse effect on a scenic vista.

b) **Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a State scenic highway?**

**No impact.** No features of the project would substantially damage scenic resources. No damage to trees, rock outcroppings, and historic buildings will occur The site is not near a State scenic highway

c) **Substantially degrade the existing visual character or quality of the site and its surroundings?**

**No impact.** There will be nothing to substantially degrade the existing visual character or quality of the site.

d) **Create a new source of substantial light or glare which would adversely affect day or nighttime views in the area?**

**No impact.** The project will not require lighting at night.

II. AGRICULTURE RESOURCES - **In determining whether impacts to agricultural resources are significant environmental effects, lead agencies may refer to the California Agricultural Land Evaluation and Site Assessment Model (1997) prepared by the California Department of Conservation as an optional model to use in assessing impacts on agriculture and farmland. Would the project:**

a) **Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to nonagricultural use?**

**Less than significant impact.** The project does not affect the net land available for farming under current practices Currently, the 1-acre land is in fallow and not being used for farming The land could be used for farming when recharge is not in progress

b) **Conflict with existing zoning for agricultural use or a Williamson Act contract?**

**No impact.** The project does not affect the net land available for farming under current practices Currently, the 1-acre land is in fallow and not being used for farming The land could be used for farming when recharge is not in progress The only Williamson Act parcels in Los Angeles County are in Santa Catalina Island

c) **Involve other changes in the existing environment, which due to their location or nature, could result in conversion of Farmland to nonagricultural use?**

**No impact.** The project does not affect the net land available for farming under current practices. Currently, the 1-acre land is in fallow and not being used for farming The land could be used for farming when recharge is not in progress.

III. AIR QUALITY - **Where available, the significance criteria established by the applicable air quality management or air pollution control district may be relied upon to make the following determinations. Would the project**:

a) **Conflict with or obstruct implementation of the applicable air quality plan?**

**Less than significant impact.** A project would be deemed inconsistent with the air quality plans if it results in population or employment growth that exceeds projected growth estimates for the area The proposed project will not result in population or employment growth, thus, will not conflict with the implementation of the applicable air quality plan.

b) **Violate any air quality standard or contribute substantially to an existing or projected air quality violation?**

**Less than significant impact.** Project emissions will be negligible and will not violate any air quality standards for the Antelope Valley Air Quality Management District and the Kern County Air Pollution Control District due to such a small area of land used and sufficient soils will be underwater, which will control dust. A diesel engine drill rig will be used but only for three to four days and the engine will be shut off when not in use. Negligible greenhouse gases will be emitted as only a few motor vehicles traveling to the site would be traveling to the area regardless of the project.

c) **Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable Federal or State ambient air quality standard (including releasing emissions which exceed quantitative thresholds for ozone precursors)?**

**Less than significant impact.** Project specifications would require the contractor to comply with Federal and State emission control regulations. The negligible emissions during ongoing project operations and the potential effects of the project's use of fossil fuels will not contribute to the cumulative increase in emissions associated with past, present, and future development.

d) **Expose sensitive receptors to substantial pollutant concentrations?**

**Less than significant impact.** The negligible emissions during ongoing project operations and the potential effects of the project's use of fossil fuels during the project construction and operation will not create significant concentrations of pollutants. Any dust will be controlled by appropriate means such as watering.

e) **Create objectionable odors affecting a substantial number of people?**

**No Impact.** The project will not emit objectionable odors.

IV. <u>BIOLOGICAL RESOURCES - Would the project</u>:

a) **Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game (DFG) or U.S. Fish and Wildlife Service?**

**Less than significant impact.** The project will not modify wildlife habitat because the land is not riparian and has already been disturbed. The equipment is already in place and activities will not disturb any potentially protected species. Field observations and a California Natural Diversity Database records review showed special status species such as burrowing owls, swainson's hawks, and mountain plover within the area but not at the particular site.

b) **Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?**

**No Impact.** The project will not be located on riparian or other sensitive habitats

c) **Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?**

**No impact.** No wetlands exist on the proposed project lands.

d) **Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites?**

**Less than significant impact.** The project will not modify wildlife habitat because the land is not riparian and has already been disturbed The project site use of 1 acre is minimal in comparison with the surrounding available open land as well as being located in such a remote area The monitoring well is already in place and activities will not disturb any potentially protected species.

e) **Conflict with any local policies or ordinances protecting biological resources such as a tree preservation policy or ordinance?**

**No Impact.** The project does not violate any local policies or ordinances related to preservation.

f) **Conflict with the provisions of an adopted Habitat Conservation Plan; Natural Community Conservation Plan; or other approved local, regional, or State Habitat Conservation Plan?**

**No impact.** The project occurs in the general area of the West Mojave Plan but does not affect any wildlife habitat or species addressed by this plan There are no California Natural Diversity Database records of desert tortoise in the area, and the site is not within the range of desert tortoise under the West Mojave Plan The nearest location for Mojave ground squirrel is 5 miles away, and the West Mojave Plan does not map the project site within the range of the species.

V. <u>CULTURAL RESOURCES - Would the project</u>:

a) **Cause a substantial adverse change in the significance of a historical resource as defined in Section 15064.5?**

**No impact.** The proposed project is not located on a site of known historical significance

b) **Cause a substantial adverse change in the significance of an archaeological resource pursuant to Section 15064.5?**

**No impact.** The proposed project is not located on a site of known historical significance.

c) **Directly or indirectly destroy a unique paleontological resource, site, or unique geologic feature?**

**No Impact.** No paleontological resources were identified during the cultural survey No impacts are anticipated

d) **Disturb any human remains, including those interred outside formal cemeteries?**

**Less than significant impact.** In the event of an accidental discovery, construction would be halted and diverted away from the site of discovery in addition to compliance with Health and Safety Code 7050 5, California Environmental Quality Act 15064.5(e), and Public Resources Code 5097.98.

VI. <u>GEOLOGY AND SOILS - Would the project</u>:

a) **Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:**

i) **Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.**

**No impact.** There will be no structures to be affected

ii) **Strong seismic ground shaking?**

**No impact.** There will be no structures to be affected

iii) **Seismic-related ground failure, including liquefaction?**

**No impact.** There will be no rise in water level as the project will conclude shortly after infiltrated water reaches the water table

iv) **Landslides?**

**No impact.** There are no potential landslide areas in the vicinity of the proposed project.

b) **Result in substantial soil erosion or the loss of topsoil?**

**No impact.** There will be no erosion or loss of topsoil.

c) **Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse?**

**No impact.** The project is not located on unstable land nor will become unstable because there will be no rise in water level as the project will conclude shortly after infiltrated water reaches the water table.

d) **Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property?**

**No impact.** The project is not located on an expansive soil type.

e) **Have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater?**

**No impact.** Septic systems are not an aspect of the project

VII. HAZARDS AND HAZARDOUS MATERIALS - Would the project:

a) **Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?**

**No impact.** The project does not require the transport, use, or disposal of any hazardous material

b) **Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment?**

**No impact.** The project does not require the transport, use, or disposal of any hazardous material

c) **Emit hazardous emissions or handle hazardous materials, substances, or wastes within one-quarter mile of an existing or proposed school?**

**No Impact.** There are no schools within 0.25 miles of the project area where hazardous materials may be handled

d) **Be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code, Section 65962.5, and, as a result, would it create a significant hazard to the public or the environment?**

**No impact.** The project is not located on a known hazardous materials site.

e) **For a project located within an airport land use plan or where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project result in a safety hazard for people residing or working in the project area?**

**No impact.** The project is not located within an airport land use plan or within 2 miles of any airport.

f) **For a project within the vicinity of a private airstrip, would the project result in a safety hazard for people residing or working in the project area?**

**No impact.** The project is not located within the vicinity of any airstrip

g) **Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan?**

**No impact**. The project has no mechanism by which it might affect implementation of emergency responses or evacuation plans.

h) **Expose people or structures to a significant risk of loss, injury, or death involving wildland fires, including where wild lands are adjacent to urbanized areas or where residences are intermixed with wildlands?**

**No impact**. The project has no mechanism by which it would affect wildland fires.

i) **Generate vectors (flies, mosquitoes, rodents, etc.) or have a component that includes agricultural waste. Specifically, exceed the following qualitative threshold: (a) occur as immature stages and adults in numbers considerably in excess of those found in the surrounding environment; (b) are associated with design, layout, and management of project operations; (c) disseminate widely from the property; and (d) cause detrimental effects on the public health or well being of the majority of the surrounding population.**

**Less than significant impact.** The proposed project could, particularly during operations in fall and early spring, result in increases in mosquito

populations. Mosquito larvae populations will be tracked using methods and thresholds approved by the Antelope Valley Mosquito and Vector Control District. Suppression measures such as the use of mosquito-eating fish would be employed when thresholds are exceeded

## VIII. HYDROLOGY AND WATER QUALITY - Would the project:

**a) Violate any water quality standards or waste discharge requirements?**

**Less than significant impact.** As part of the experimental design, we will (1) monitor at shallow depths to ensure that arsenic is being rapidly removed as planned and (2) monitor at the water table to ensure water actually recharged is low in arsenic. If arsenic removal does not occur as planned, we will know long before the water reaches the water table. In the worst case scenario, if there is no arsenic removal, we will stop the experiment before the water infiltrates to more than 100 feet below land surface (bls) Background arsenic concentrations range from 29 micrograms per liter (µg/L) to 4 µg/L We chose the lowest concentration of 4 µg/L as the threshold concentration at 100 feet bls, where pumping will stop if that concentration is exceeded Modeling results show that the small amount of water recharged at this decision milestone (about 120 days) would not infiltrate to the water table during the 180-month (15-year) simulation period In the absolute worst case scenario, only 66 acre feet of water would be infiltrated If that small amount of water ever reaches the water table, dilution with native water or dilution with water infiltrated elsewhere on the property (anticipated to be about 30,000 acre feet per year) would render the increase in arsenic concentrations associated with the experiment at the water table beneath the site insignificant (and immeasurable).

**b) Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of preexisting nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted)?**

**No impact.** The proposed project would not cause either a net deficit in aquifer volume or a lowering of the local groundwater table level.

**c-d) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off-site or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site?**

**No impact.** The project will not be altering the drainage on site

e) **Create or contribute runoff water which would exceed the capacity of existing or planned storm water drainage systems or provide substantial additional sources of polluted runoff?**

**No impact.** The project will not create additional runoff

f) **Otherwise substantially degrade water quality?**

**Less than significant impact.** As part of the experimental design, we will (1) monitor at shallow depths to ensure that arsenic is being rapidly removed as planned and (2) monitor at the water table to ensure water actually recharged is low in arsenic. If arsenic removal does not occur as planned, we will know long before the water reaches the water table. In the worst case scenario, if there is no arsenic removal, we will stop the experiment before the water infiltrates to more than 100 feet bls. Background arsenic concentrations range from 29 µg/L to 4 µg/L We chose the lowest concentration of 4 µg/L as the threshold concentration at 100 feet bls, where pumping will stop if that concentration is exceeded. Modeling results show that the small amount of water recharged at this decision milestone (about 120 days) would not infiltrate to the water table during the 180-month (15-year) simulation period In the absolute worst case scenario, only 66 acre feet of water would be infiltrated If that small amount of water ever reaches the water table, dilution with native water or dilution with water infiltrated elsewhere on the property (anticipated to be about 30,000 acre feet per year) would render the increase in arsenic concentrations associated with the experiment at the water table beneath the site insignificant (and immeasurable)

g) **Place housing within a 100-year flood hazard area as mapped on a Federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map?**

**No impact.** The project will not place housing in the 100-year floodplain

h) **Place within a 100-year flood hazard area structures which would impede or redirect flood flows?**

**No impact.** The project will not place structures in the 100-year floodplain

i) **Expose people or structures to a significant risk of loss, injury, or death involving flooding, including flooding as a result of the failure of a levee or dam?**

**Less than significant impact.** The project does not involve creation or operation of dams or levees Temporary recharge berms and other agricultural flood irrigation methods to prevent flooding would not contain substantial quantities of water

j) **Inundation by seiche, tsunami, or mudflow?**

**No impact.** The project has no mechanism for affecting these phenomena.

IX. LAND USE AND PLANNING - Would the project:

a) **Physically divide an established community?**

**No impact.** The project would be located in a rural area, surrounded by active agricultural lands and undeveloped lands, and would not physically divide an established community in addition to the project area only covering about 1 acre.

b) **Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect?**

**No impact.** The proposed project is not in conflict with planning in either the Los Angeles or Kern Counties.

c) **Conflict with any applicable habitat conservation plan or natural community conservation plan?**

**No impact.** The project occurs in the general area of the West Mojave Plan but does not affect any wildlife habitat or species addressed by this plan. There are no California Natural Diversity Database records of desert tortoise in the area and the site is not within the range of desert tortoise under the West Mojave Plan. The nearest location for Mojave ground squirrel is 5 miles away, and the West Mojave Plan does not map the project site within the range of the species.

X. MINERAL RESOURCES - Would the project

a) **Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the State?**

**No impact.** The project area does not contain mineral resources of commercial value.

b) **Result in the loss of availability of a locally important mineral resource recovery site delineated on a local general plan, specific plan, or other land use plan?**

**No impact.** The project area does not contain mineral resources of commercial value.

XI. NOISE - Would the project result in.

a) **Exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies?**

**Less than significant impact.** The project may cause temporary adverse noise impacts but there are no residents living in the vicinity of construction activities. General noise reduction strategies would be implemented such as equipment with sound-control devices, time restrictions on construction, and possible equipment relocation and/or rescheduling.

b) **Exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels?**

**No impact.** The proposed project will not involve the use of equipment that generated substantial groundborne vibration or noise

c) **A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project?**

**No impact.** There will be no permanent increase in noise levels

d) **A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project?**

**Less than significant impact.** The project may cause temporary adverse noise impacts but there are no residents living in the vicinity of construction activities. General noise reduction strategies would be implemented such as equipment with sound-control devices, time restrictions on construction, and possible equipment relocation and/or rescheduling.

e) **For a project located within an airport land use plan or where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?**

**No impact.** The project is not within an airport land use plan

f) **For a project within the vicinity of a private airstrip, would the project expose people residing or working in the project area to excessive noise levels?**

**No impact.** The project will not have airport-related noise impacts.

## XII. POPULATION AND HOUSING - Would the project:

a) **Induce substantial population growth in an area either directly (e.g., by proposing new homes and businesses) or indirectly (e.g., through extension of roads or other infrastructure)?**

**No impact.** Based on consideration of the nature of the project and the historic and present relationship between such projects and growth, the proposed project would not induce growth

b) **Displace substantial numbers of existing housing, necessitating the construction of replacement housing elsewhere?**

**No impact.** The project does not displace housing

c) **Displace substantial numbers of people, necessitating the construction of replacement housing elsewhere?**

**No impact.** The project does not displace people

d) **Result in a substantial unbalanced or disproportional distribution of impacts of any type on a disadvantaged demographic, such as concentration of toxic emissions in an area of low income families versus high income family.**

**No impact.** The project does not result in distribution of impacts to a disadvantaged demographic. Impacts are distributed among counties and in areas with and without housing

## XIII. PUBLIC SERVICES

a) **Would the project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts in order to maintain acceptable service ratios, response times, or other performance objectives for any of the public services: Fire protection, police protection, schools, parks, other public facilities?**

**No impact.** No significant impacts are anticipated because the project has no mechanism by which demand for public services would be altered substantially

## XIV. RECREATION

a) **Would the project increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?**

**No impact.** There is no mechanism by which the project alternatives would increase recreational use of existing facilities.

b) **Does the project include recreational facilities or require the construction or expansion of recreational facilities which might have an adverse physical effect on the environment?**

**No impact.** The project does not include new recreation facilities.

c) **Substantially reduce recreational opportunities or substantially degrade recreational experiences.**

**No impact.** There is no mechanism by which the project alternatives would reduce recreational opportunities or degrade recreation.

## XV. TRANSPORTATION/TRAFFIC - Would the project:

a) **Cause an increase in traffic which is substantial in relation to the existing traffic load and capacity of the street system (i.e., result in a substantial increase in either the number of vehicle trips, the volume to capacity ratio on roads, or congestion at intersections)?**

**Less than significant impact.** Under the worst case scenario involving simultaneous of all drillings, pipelines, and other facilities, the project would not add traffic to local roads that would result in an increase in level of service due to being such a small project.

b) **Exceed, either individually or cumulatively, a level of service standard established by the County Congestion Management Agency for designated roads or highways?**

**No impact.** Under the worst case scenario involving simultaneous of all drillings, pipelines, and other facilities, the project would not add traffic to local roads that would result in an increase in level of service due to being such a small project.

c) **Result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that result in substantial safety risks?**

**No impact.** The project does not propose the alteration of any air-traffic patterns nor does it increase traffic levels

d) **Substantially increase hazards due to a design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)?**

**No impact.** The project does not propose any changes to existing roads nor does it increase traffic levels

e) **Result in inadequate emergency access?**

**No impact.** There will be no increase in traffic or slow-moving vehicles to affect emergency vehicle movement or access.

f) **Result in inadequate parking capacity?**

**No impact.** The project would require parking for about five employees and would be existing off-road parking

g) **Conflict with adopted policies, plans, or programs supporting alternative transportation (e.g., bus turnouts, bicycle racks)?**

**No impact.** There are no pedestrian walkways, bikeways, or roads designated as bike routes that could be potentially affected by the project construction or ongoing operation. Additionally, while plans for the area support the expansion of alternative transportation, the area is sparsely populated, and alternative means of transportation have not developed in the project vicinity. The project would also not preclude the expansion of alternative transportation in the area at some future date.

XVI. UTILITIES AND SERVICE SYSTEMS - Would the project:

a) **Exceed wastewater treatment requirements of the applicable Regional Water Quality Control Board?**

**No impact.** The project does not generate wastewater

b) **Require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?**

**No impact.** The project does not neither require new water nor generate wastewater

c) **Require or result in the construction of new stormwater drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?**

**No impact.** The project does not generate new stormwater drainage.

d) **Have sufficient water supplies available to serve the project from existing entitlements and resources, or are new or expanded entitlements needed?**

**No impact.** The project does not require water supplies.

e) **Result in a determination by the wastewater treatment provider which serves or may serve the project that it has adequate capacity to serve the project's projected demand in addition to the provider's existing commitments?**

**No impact.** The project does not generate wastewater

f) **Be served by a landfill with sufficient permitted capacity to accommodate the project's solid waste disposal needs?**

**No impact.** The project does not generate substantial solid waste and is served by a regional landfill

g) **Comply with Federal, State, and local statutes and regulations related to solid waste?**

**No impact.** The project does not generate substantial solid waste and is served by a regional landfill.

## XVII. MANDATORY FINDINGS OF SIGNIFICANCE

a) **Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal, or eliminate important examples of the major periods of California history or prehistory?**

**No impact.** The 1-acre project would not contribute to the cumulative loss of habitat or its fragmentation.

b) **Does the project have impacts that are individually limited, but cumulatively considerable? ("Cumulatively considerable" means that the incremental effects of a project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects?)**

**No impact.** No "cumulative considerable" impacts are anticipated due to the short duration of 35 months and minimal land use of 1 acre.

c) **Does the project have environmental effects which will cause substantial adverse effects on human beings, either directly or indirectly?**

**Less than significant impact.** No effects are anticipated due to the short duration of 35 months and the minimal land use of 1 acre. The project incorporated measures to avoid and minimize potential impacts in categories directly or indirectly affecting human beings Preventive measures for a cultural discovery, hydrology and water quality, mosquito management, and noise control would effectively reduce any impacts to a level of less than significant.

# COUNTY OF LOS ANGELES

## DEPARTMENT OF PUBLIC WORKS

*"To Enrich Lives Through Effective and Caring Service"*

GAIL FARBER, Director

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IN REPLY PLEASE
REFER TO FILE: WW-1

April 1, 2010

Mr Mike Plaziak
Water Resources Control Engineer
California Regional Water Quality Control Board
Lahontan Region (6B)
14440 Civic Drive, Suite 200
Victorville, CA 92392

Dear Mr Plaziak.

**LOS ANGELES COUNTY WATERWORKS DISTRICT NO. 40, ANTELOPE VALLEY REGION 4, LANCASTER**
**RESPONSE TO COMMENTS ON NEGATIVE DECLARATION FOR IN-SITU ARSENIC REMOVAL ON UNSATURATED ALLUVIUM**
**STATE CLEARINGHOUSE NO. 2010021052**

Thank you for your review and comment on our draft Negative Declaration for the In-situ Arsenic Removal project. You commented that we should submit a Report of Waste Discharge for the project and that the report should contain detailed information covering vadose zone modeling, infiltration calculations, soil hydraulic parameters, and a vadose zone monitoring plan The report was already submitted to the Lahontan Regional Water Quality Control Board (LRWQCB) on February 17, 2010, when the California Environmental Quality Act public review process for the project began The report included the information you requested The report provides further detailed information explaining the discharge process such that no change in water quality shall occur

Enclosed is a copy of the report that was sent to the LRWQCB on February 12, 2010 We anticipate certification of the Negative Declaration on May 7, 2010 If you have any questions or require additional information, please contact Mr Clark Ajwani at (626) 300-4687 or cajwani@dpw lacounty.gov

Very truly yours,

GAIL FARBER
Director of Public Works

FOR ADAM ARIKI
Assistant Deputy Director
Waterworks Division

CA.lr
LTS69

Enc

# INTRODUCTION

This application package constitutes a Report of Waste Discharge (ROWD) pursuant to California Water Code Section 13260 Section 13260 states that persons discharging or proposing to discharge waste that could affect the quality of the waters of the State, other than into a community sewer system, shall file a ROWD containing information which may be required by the appropriate Regional Water Quality Control Board (RWQCB).

This package is to be used to start the application process for all waste discharge requirements (WDRs) and National Pollutant Discharge Elimination System (NPDES) permits* issued by a RWQCB except:

a) Those landfill facilities that must use a joint Solid Waste Facility Permit Application Form, California Integrated Waste Management Board Form E-1-77, and
b) General WDRs or general NPDES permits that use a Notice of Intent to comply or specify the use of an alternative application form designed for that permit.

**This application package contains:**

1 Application/General Information Form for WDRs and NPDES Permits [Form 200 (10/97)]
2 Application/General Information Instructions

## Instructions

Instructions are provided to assist you with completion of the application. If you are unable to find the answers to your questions or need assistance with the completion of the application package, please contact your RWQCB representative. *The RWQCBs strongly recommend that you make initial telephone or personal contact with RWQCB regulatory staff to discuss a proposed new discharge before submitting your application.* The RWQCB representative will be able to answer procedural and annual fee related questions that you may have. (See map and telephone numbers inside of application cover.)

All dischargers regulated under WDRs and NPDES permits must pay an annual fee, except dairies, which pay a filing fee only. The RWQCB will notify you of your annual fee based on an evaluation of your proposed discharge. Please do NOT submit a check for your first annual fee or filing fee until requested to do so by a RWQCB representative. Dischargers applying for reissuance (renewal) of an existing NPDES permit or update of an existing WDR will be billed through the annual fee billing system and are therefore requested NOT to submit a check with their application. Checks should be made payable to the State Water Resources Control Board.

## Additional Information Requirements

A RWQCB representative will notify you within 30 days of receipt of the application form and any supplemental documents whether your application is complete. If your application is incomplete, the RWQCB representative will send you a detailed list of discharge specific information necessary to complete the application process. The completion date of your application is normally the date when all required information, including the correct fee, is received by the RWQCB.

*** NPDES PERMITS:** If you are applying for a permit to discharge to surface water, you will need an NPDES permit which is issued under both State and Federal law and may be required to complete one or more of the following Federal NPDES permit application forms: Short Form A, Standard Form A, Forms 1, 2B, 2C, 2D, 2E, and 2F. These forms may be obtained at a RWQCB office or can be ordered from the National Center for Environmental Publications and Information at (513) 891-6561

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

State of California
Regional Water Quality Control Board

**APPLICATION/REPORT OF WASTE DISCHARGE**
**GENERAL INFORMATION FORM FOR**
**WASTE DISCHARGE REQUIREMENTS OR NPDES PERMIT**

# INSTRUCTIONS

## FOR COMPLETING THE APPLICATION/REPORT OF WASTE DISCHARGE GENERAL INFORMATION FORM FOR: WASTE DISCHARGE REQUIREMENTS/NPDES PERMIT

If you have any questions on the completion of any part of the application, please contact your RWQCB representative. A map of RWQCB locations, addresses, and telephone numbers is located on the reverse side of the application cover

### I. FACILITY INFORMATION

You must provide the factual information listed below for ALL owners, operators, and locations and, where appropriate, for ALL general partners and lease holders.

**A. FACILITY:**
Legal name, physical address including the county, person to contact, and phone number at the facility (**NO P.O. Box numbers!** If no address exists, use street and nearest cross street.)

**B. FACILITY OWNER:**
Legal owner, address, person to contact, and phone number Also include the owner's Federal Tax Identification Number

**OWNER TYPE:**
Check the appropriate Owner Type. The legal owner will be named in the WDRs/NPDES permit.

**C FACILITY OPERATOR (The agency or business, not the person):**
If applicable, the name, address, person to contact, and telephone number for the facility operator Check the appropriate Operator Type. If identical to B. above, enter "same as owner"

**D. OWNER OF THE LAND:**
Legal owner of the land(s) where the facility is located, address, person to contact, and phone number Check the appropriate Owner Type. If identical to B. above, enter "same as owner"

**E. ADDRESS WHERE LEGAL NOTICE MAY BE SERVED:**
Address where legal notice may be served, person to contact, and phone number If identical to B. above, enter "same as owner"

**F BILLING ADDRESS**
Address where annual fee invoices should be sent, person to contact, and phone number If identical to B. above, enter "same as owner"

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

State of California
Regional Water Quality Control Board

# APPLICATION/REPORT OF WASTE DISCHARGE GENERAL INFORMATION FORM FOR WASTE DISCHARGE REQUIREMENTS OR NPDES PERMIT

## II. TYPE OF DISCHARGE

Check the appropriate box to describe whether the waste will be discharged to A Land, or B Surface Water

Check the appropriate box(es) which best describe the activities at your facility

Hazardous Waste **If you check the Hazardous Waste box,** STOP **and contact a representative of the RWQCB for further instructions.**

Landfills - **A separate form, APPLICATION FOR SOLID WASTE FACILITY PERMIT/WASTE DISCHARGE REQUIREMENTS, California Integrated Waste Management Board Form E-1-77, may be required. Contact a RWQCB representative to help determine the appropriate form for your discharge.**

## III. LOCATION OF THE FACILITY

1 Enter the Assessor's Parcel Number(s) (APN), which is located on the property tax bill. The number can also be obtained from the County Assessor's Office. Indicate the APN for both the facility and the discharge point.

2 Enter the Latitude of the entrance to the proposed/existing facility and of the discharge point. Latitude and longitude information can be obtained from a U.S. Geological Survey quadrangle topographic map. Other maps may also contain this information.

3 Enter the Longitude of the entrance to the proposed/existing facility and of the discharge point.

## IV. REASON FOR FILING

**NEW DISCHARGE OR FACILITY:**
A discharge or facility that is proposed but does not now exist, or that does not yet have WDRs or an NPDES permit.

**CHANGE IN DESIGN OR OPERATION:**
A material change in design or operation from existing discharge requirements. Final determination of whether the reported change is material will be made by the RWQCB

**CHANGE IN QUANTITY/TYPE OF DISCHARGE:**
A material change in characteristics of the waste from existing discharge requirements. Final determination of whether the reported change would have a significant effect will be made by the RWQCB.

**CHANGE IN OWNERSHIP/OPERATOR:**
Change of legal owner of the facility Complete Parts I, III, and IV only and contact the RWQCB to determine if additional information is required.

**WASTE DISCHARGE REQUIREMENTS UPDATE OR NPDES PERMIT REISSUANCE:**
WDRs must be updated periodically to reflect changing technology standards and conditions. A new application is required to reissue an NPDES permit which has expired.

**OTHER:**
If there is a reason other than the ones listed, please describe the reason on the space provided. (If more space is needed, attach a separate sheet.)

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

State of California
Regional Water Quality Control Board

# APPLICATION/REPORT OF WASTE DISCHARGE GENERAL INFORMATION FORM FOR WASTE DISCHARGE REQUIREMENTS OR NPDES PERMIT

## V. CALIFORNIA ENVIRONMENTAL QUALITY ACT (CEQA)

It should be emphasized that communication with the appropriate RWQCB staff is vital before starting the CEQA documentation, and is recommended before completing this application. There are Basin Plan issues which may complicate the CEQA effort, and RWQCB staff may be able to help in providing the needed information to complete the CEQA documentation.

Name the Lead Agency responsible for completion of CEQA requirements for the project, i.e., completion and certification of CEQA documentation.

Check YES or NO. Has a public agency determined that the proposed project is exempt from CEQA?
If the answer is YES, state the basis for the exemption and the name of the agency supplying the exemption on the space provided. (Remember that, if extra space is needed, use an extra sheet of paper, but be sure to indicate the attached sheet under Section VII. Other )

Check YES or NO Has the "Notice of Determination" been filed under CEQA? If YES, give the date the notice was filed and enclose a copy of the Notice of Determination and the Initial Study, Environmental Impact Report, or Negative Declaration. If NO, check the box of the expected type of CEQA document for this project, and include the expected date of completion using the timelines given under CEQA. The date of completion should be taken as the date that the Notice of Determination will be submitted. (If not known, write "Unknown")

## VI. OTHER REQUIRED INFORMATION

To be approved, your application MUST include a COMPLETE characterization of the discharge. If the characterization is found to be incomplete, RWQCB staff will contact you and request that additional specific information be submitted.

This application MUST be accompanied by a site map. A USGS 7.5' Quadrangle map or a street map, if more appropriate, is sufficient for most applications.

## VII. OTHER

If any of the answers on your application form need further explanation, attach a separate sheet. Please list any attachments with the titles and dates on the space provided.

## VIII. CERTIFICATION

Certification by the owner of the facility or the operator of the facility, if the operator is different from the owner, is required. The appropriate person must sign the application form.
Acceptable signatures are:

1. **for a corporation,** a principal executive officer of at least the level of senior vice-president;
2. **for a partnership or individual (sole proprietorship),** a general partner or the proprietor;
3. **for a governmental or public agency,** either a principal executive officer or ranking elected/appointed official.

# DISCHARGE SPECIFIC INFORMATION

In most cases, a request to supply additional discharge specific information will be sent to you by a representative of the RWQCB. If the RWQCB determines that additional discharge specific information is not needed to process your application, you will be so notified.

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

State of California
Regional Water Quality Control Board

# APPLICATION/REPORT OF WASTE DISCHARGE
# GENERAL INFORMATION FORM FOR
# WASTE DISCHARGE REQUIREMENTS OR NPDES PERMIT

## I. FACILITY INFORMATION

### A. Facility:

| | | | |
|---|---|---|---|
| Name: Antelope Valley - East Kern Water Agency | | | |
| Address: 6500 West Avenue N | | | |
| City: Palmdale | County: Los Angeles | State: CA | Zip Code: 93551-2865 |
| Contact Person: Mike Flood | | Telephone Number: (310) 555-1220 | |

### B. Facility Owner:

| | | | |
|---|---|---|---|
| Name: Antelope Valley - East Kern Water Agency | | | Owner Type (Check One) 1. ☐ Individual 2. ☐ Corporation |
| Address: 6500 West Avenue N | | | 3. ☑ Governmental Agency 4. ☐ Partnership |
| City: Palmdale | State: CA | Zip Code: 93551-2865 | 5. ☐ Other: |
| Contact Person: Mike Flood | | Telephone Number: (310) 555-1220 | Federal Tax ID: |

### C. Facility Operator (The agency or business, not the person):

| | | | |
|---|---|---|---|
| Name: Los Angeles County Public Works - Waterworks | | | Operator Type (Check One) 1. ☐ Individual 2. ☐ Corporation |
| Address: 1000 S. Fremont Ave. Building A-9E, 4th Floor | | | 3. ☑ Governmental Agency 4. ☐ Partnership |
| City: Alhambra | State: CA | Zip Code: 91803-1331 | 5. ☐ Other: |
| Contact Person: Clark Ajwani | | Telephone Number: 626-300-4687 | |

### D. Owner of the Land:

| | | | |
|---|---|---|---|
| Name: Antelope Valley - East Kern Water Agency | | | Owner Type (Check One) 1. ☐ Individual 2. ☐ Corporation |
| Address: 6500 West Avenue N | | | 3. ☑ Governmental Agency 4. ☐ Partnership |
| City: Palmdale | State: CA | Zip Code: 93551-2865 | 5. ☐ Other: |
| Contact Person: Mike Flood | | Telephone Number: (310) 555-1220 | |

### E. Address Where Legal Notice May Be Served:

| | | |
|---|---|---|
| Address: P.O. Box 1460 | | |
| City: Alhambra | State: CA | Zip Code: 91802-1460 |
| Contact Person: Clark Ajwani | | Telephone Number: 626-300-4687 |

### F. Billing Address:

| | | |
|---|---|---|
| Address: P.O. Box 1460 | | |
| City: Alhambra | State: CA | Zip Code: 91802-1460 |
| Contact Person: Clark Ajwani | | Telephone Number: 626-300-4687 |

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

State of California
Regional Water Quality Control Board

# APPLICATION/REPORT OF WASTE DISCHARGE GENERAL INFORMATION FORM FOR WASTE DISCHARGE REQUIREMENTS OR NPDES PERMIT

## II. TYPE OF DISCHARGE

**Check Type of Discharge(s) Described in this Application (A or B):**

☑ **A. WASTE DISCHARGE TO LAND** ☐ **B. WASTE DISCHARGE TO SURFACE WATER**

**Check all that apply:**

- ☐ Domestic/Municipal Wastewater Treatment and Disposal
- ☐ Cooling Water
- ☐ Mining
- ☐ Waste Pile
- ☐ Wastewater Reclamation
- ☑ Other, please describe: Groundwater
- ☐ Animal Waste Solids
- ☐ Land Treatment Unit
- ☐ Dredge Material Disposal
- ☐ Surface Impoundment
- ☐ Industrial Process Wastewater
- ☐ Animal or Aquacultural Wastewater
- ☐ Biosolids/Residual
- ☐ Hazardous Waste (see instructions)
- ☐ Landfill (see instructions)
- ☐ Storm Water

## III. LOCATION OF THE FACILITY

**Describe the physical location of the facility.**

| 1. Assessor's Parcel Number(s) | 2. Latitude | 3. Longitude |
|---|---|---|
| **Facility:** N/A | **Facility:** 34 797427 | **Facility:** 118.405283 |
| **Discharge Point:** N/A | **Discharge Point:** 34 797427 | **Discharge Point:** -118.405283 |

## IV. REASON FOR FILING

- ☑ New Discharge or Facility
- ☐ Change in Design or Operation
- ☐ Change in Quantity/Type of Discharge
- ☐ Changes in Ownership/Operator (see instructions)
- ☐ Waste Discharge Requirements Update or NPDES Permit Reissuance
- ☐ Other: _____

## V. CALIFORNIA ENVIRONMENTAL QUALITY ACT (CEQA)

**Name of Lead Agency:** Los Angeles County Public Works · Waterworks

**Has a public agency determined that the proposed project is exempt from CEQA?** ☐ **Yes** ☑ **No**

**If Yes, state the basis for the exemption and the name of the agency supplying the exemption on the line below.**

**Basis for Exemption/Agency:** _____

**Has a "Notice of Determination" been filed under CEQA?** ☐ **Yes** ☑ **No**

**If Yes, enclose a copy of the CEQA document, Environmental Impact Report, or Negative Declaration. If no, identify the expected type of CEQA document and expected date of completion.**

Expected CEQA Documents:

☐ **EIR** ☑ **Negative Declaration**

**Expected CEQA Completion Date:** May 8, 2010

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

State of California
Regional Water Quality Control Board

# APPLICATION/REPORT OF WASTE DISCHARGE GENERAL INFORMATION FORM FOR WASTE DISCHARGE REQUIREMENTS OR NPDES PERMIT

## VI. OTHER REQUIRED INFORMATION

Please provide a COMPLETE characterization of your discharge. A complete characterization includes, but is not limited to, design and actual flows, a list of constituents and the discharge concentration of each constituent, a list of other appropriate waste discharge characteristics, a description and schematic drawing of all treatment processes, a description of any Best Management Practices (BMPs) used, and a description of disposal methods.

Also include a site map showing the location of the facility and, if you are submitting this application for an NPDES permit, identify the surface water to which you propose to discharge. Please try to limit your maps to a scale of 1:24,000 (7.5' USGS Quadrangle) or a street map, if more appropriate.

## VII. OTHER

**Attach additional sheets to explain any responses which need clarification. List attachments with titles and dates below:**

_____

_____

_____

**You will be notified by a representative of the RWQCB within 30 days of receipt of your application. The notice will state if your application is complete or if there is additional information you must submit to complete your Application/Report of Waste Discharge, pursuant to Division 7, Section 13260 of the California Water Code.**

## VIII. CERTIFICATION

**"I certify under penalty of law that this document, including all attachments and supplemental information, were prepared under my direction and supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment."**

**Print Name:** DANIEL J. LAFFERTY **Title:** PRINCIPAL ENGINEER

**Signature** Daniel J. Lafferty **Date:** 4/1/10

**FOR OFFICE USE ONLY**

| Date Form 200 Received: | Letter to Discharger: | Fee Amount Received: | Check #: |
|---|---|---|---|
| | | | |

# California Environmental Protection Agency
# Bill of Rights for Environmental
# Permit Applicants

California Environmental Protection Agency (Cal/EPA) recognizes that many complex issues must be addressed when pursuing reforms of environmental permits and that significant challenges remain. We have initiated reforms and intend to continue the effort to make environmental permitting more efficient, less costly, and to ensure that those seeking permits receive timely responses from the boards and departments of the Cal/EPA. To further this goal, Cal/EPA endorses the following precepts that form the basis of a permit applicant's "Bill of Rights."

1 Permit applicants have the right to assistance in understanding regulatory and permit requirements. All Cal/EPA programs maintain an Ombudsman to work directly with applicants. Permit Assistance Centers located throughout California have permit specialists from all the State, regional, and local agencies to identify permit requirements and assist in permit processing.

2 Permit applicants have the right to know the projected fees for review of applications, how any costs will be determined and billed, and procedures for resolving any disputes over fee billings.

3 Permit applicants have the right of access to complete and clearly written guidance documents that explain the regulatory requirements. Agencies must publish a list of all information required in a permit application and of criteria used to determine whether the submitted information is adequate.

4 Permit applicants have the right of timely completeness determinations for their applications. In general, agencies notify the applicant within 30 days of any deficiencies or determine that the application is complete. California Environmental Quality Act (CEQA) and public hearing requests may require additional information.

5 Permit applicants have the right to know exactly how their applications are deficient and what further information is needed to make their applications complete. Pursuant to California Government code Section 65944, after an application is accepted as complete, an agency may not request any new or additional information that was not specified in the original application.

6 Permit applicants have the right of a timely decision on their permit application. The agencies are required to establish time limits for permit reviews.

7 Permit applicants have the right to appeal permit review time limits by statute or administratively that have been violated without good cause. For state environmental agencies, appeals are made directly to the Cal/EPA Secretary or to a specific board. For local environmental agencies, appeals are generally made to the local governing board or, under certain circumstances, to Cal/EPA. Through this appeal, applicants may obtain a set date for a decision on their permit and, in some cases, a refund of all application fees (ask boards and departments for details).

8 Permit applicants have the right to work with a single lead agency where multiple environmental approvals are needed. For multiple permits, all agency actions can be consolidated under a lead agency For site remediation, all applicable laws can be administered through a single agency

9 Permit applicants have the right to know who will be reviewing their application and the time required to complete the full review process.

## VI. OTHER REQUIRED INFORMATION

### Summary

The purpose of this project is to determine the effectiveness and sustainability of naturally occurring alumina, iron, and manganese oxides in the unsaturated zone to treat high-arsenic water Results of the study will be used to develop a methodology to transfer the technique to areas having high-arsenic water Water containing arsenic concentrations of about 30 ppb will be pumped from a well on the proposed site that is perforated opposite the lower aquifer and infiltrated into a one-acre pond. Water infiltrated from the pond will recharge the upper aquifer at the site that contains low concentrations of arsenic. The effectiveness of naturally occurring alumina, iron, and manganese oxides in the unsaturated zone to sorb arsenic will be evaluated on the basis of arsenic concentration data from suction-cup lysimeters installed in an instrumented borehole adjacent to the pond. In addition, matric potential will be monitored as water infiltrates to the water table to determine the downward rate of water movement and the extent of lateral spreading of infiltrated water Arsenic concentrations and toxicity characterization of unsaturated materials will be determined as part of this work. Laboratory studies will be done to determine physical and chemical properties of alluvium that control arsenic sorption and the long-term fate and potential release of arsenic sorbed to unsaturated alluvium.

### Background

During an artificial recharge experiment along the Oro Grande Wash in the Mojave Desert, arsenic in groundwater pumped into a recharge pond was rapidly sorbed as the water infiltrated through the unsaturated zone. This sorption was on naturally occurring alumina, iron, and manganese oxides present on the surfaces of mineral grains. These oxides are similar to those used in commercial resins. During the experiment, the upper 20 feet of unsaturated material underlying the pond lowered arsenic concentrations in 1,050 acre-feet of water infiltrated at the site from 10 ppb to less than 1 ppb. As water from the Oro Grande recharge pond infiltrated to greater depths, the amount of lateral spreading from the pond increased. The one-acre pond had an average wetted footprint in the unsaturated zone of about 30 acres (Izbicki and others, 2008a). Assuming similar sorptive capacity and a similar amount of lateral spreading within the unsaturated zone beneath Antelope Valley, the total volume of unsaturated material encountered by water infiltrated from a one-acre pond could treat 100,000 acre-feet of water Assuming an average infiltration rate of 2 feet/day through the bottom of the pond, 450 gallons/minute of water could be treated using this approach for more than 100 years before the sorptive capacity of a 300-foot thick unsaturated zone would be exhausted. The project will demonstrate the effectiveness of in-situ remediation of arsenic and will treat an estimated 3,200 acre-feet of groundwater having high-arsenic concentrations.

Table 1.—Expected chemistry of water to be recharged at the treatment site.

[Data from analysis of water from well RG-5 by Antelope Valley East Kern Water District June 14, 2007. ND, not detected.]

| | | |
|---|---|---|
| pH | | 7.9 |
| Specific conductance | microSiemens per centimeter | 430 |
| Residue on Evaporation | milligrams per liter | 290 |
| Calcium | milligrams per liter | 42 |
| Magnesium | milligrams per liter | 4.6 |
| Sodium | milligrams per liter | 49 |
| Alkalinity | milligrams per liter as CaCO3 | 143 |
| Sulfate | milligrams per liter | 28 |

| | | |
|---|---|---|
| Chloride | milligrams per liter | 50 |
| Nitrate | milligrams per liter as NO3 | 13 |
| Nitrite | milligrams per liter as N | ND |
| Fluoride | milligrams per liter | 0.37 |
| Aluminum | micrograms per liter | ND |
| Antimony | micrograms per liter | ND |
| Arsenic | micrograms per liter | 29 |
| Barium | micrograms per liter | 17 |
| Beryllium | micrograms per liter | ND |
| Boron | milligrams per liter | 0.6 |
| Cadmium | micrograms per liter | ND |
| Chromium (Cr III + Cr VI) | micrograms per liter | 3.2 |
| Chromium VI | micrograms per liter | 2.8 |
| Copper | micrograms per liter | ND |
| Iron | micrograms per liter | ND |
| Lead | micrograms per liter | ND |
| Manganese | micrograms per liter | ND |
| Mercury | micrograms per liter | ND |
| Nickel | micrograms per liter | ND |
| Selenium | micrograms per liter | ND |
| Silver | micrograms per liter | ND |
| Thallium | micrograms per liter | ND |
| Vanadium | micrograms per liter | ND |

Note: There were no detections of organic compounds in water from well RG-5.

Arsenic was strongly sorbed at the Oro Grande site. Arsenic concentrations were reduced from about 10 ppb to less than 1 ppb within the first 20 feet of alluvium Concentrations increased only slightly at that depth during the 3 years of infiltration at the site and arsenic concentrations in water reaching the water table 400 ft below land surface were low (<1 ppb)

During the experiment, arsenic at the proposed site is expected to be sorbed primarily on iron manganese and alumina oxide sorption sites in the near surface alluvium (similar to Oro Grande). The sorption sites in the deeper alluvium provide a tremendous removal capability that is expected to require many decades to saturate. The expected concentration of arsenic entering the groundwater of the shallow aquifer is <1 ppb.

**Location**

The proposed treatment site is in the northwestern part of the Lancaster subbasin, north of the Antelope Buttes, approximately 16 miles northwest of Lancaster, California (Figure 1). The site encompasses about 1,500 acres and is owned by Antelope Valley East Kern Water Agency (AVEK) Approximately one acre of the land will be used for this work at Avenue B-8 and 155th Street West in Willow Springs, CA (Figure 2). Historically, the site has been used for agricultural purposes, primarily row crops and alfalfa. In 2008, the water table was about 250 feet below land surface (bls) in the eastern part of the project area. The unsaturated alluvial deposits at the site consist of interbedded heterogeneous mixtures of silt, sand, and gravel. Given the depositional environment, unsaturated alluvium is expected to contain paleosols having sufficient alumina, iron, and manganese oxide development to sorb arsenic in water infiltrated from ponds. Due to the thick unsaturated zone and low-permeability paleosols, it may take as long as two years for the infiltrated water to reach the water table.

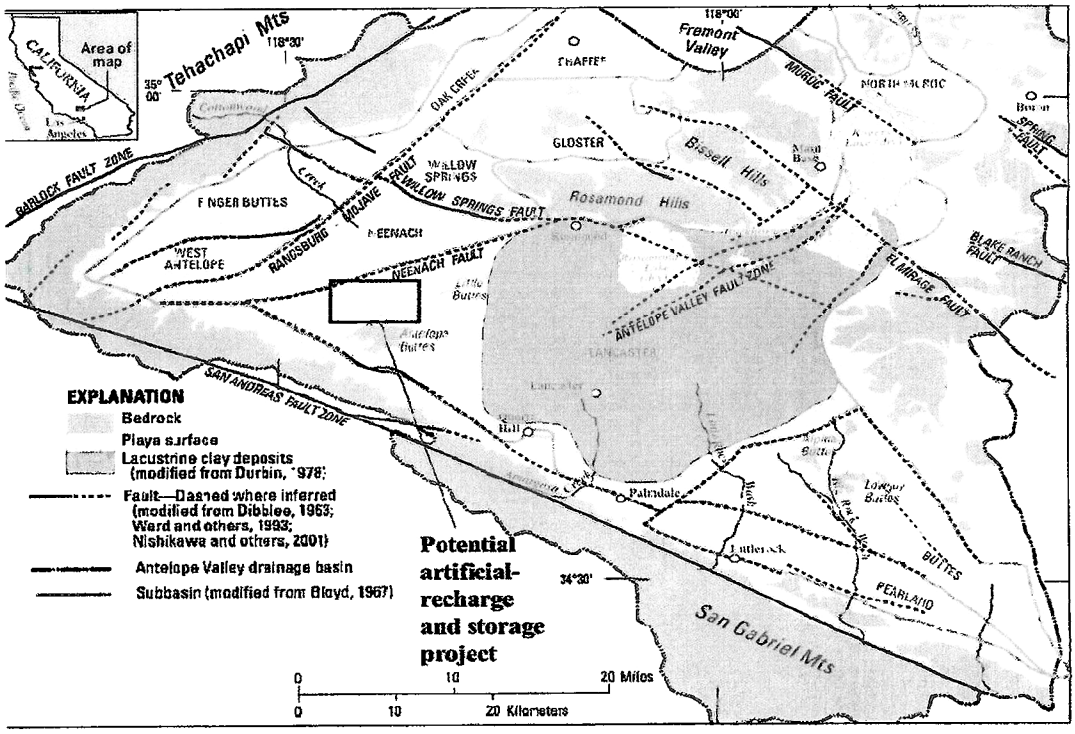


Figure 1.—Study area location


Figure 2. – Site Property Map

## Approach

Task 1. Installation of an Instrumented Borehole

An instrumented borehole will be installed in the unsaturated zone adjacent to the proposed pond location. The borehole will be drilled using the ODEX (Overburden Drilling EXploration) method. This drilling method uses air rather than water as a drilling fluid, because water would contaminate unsaturated deposits altering their matric potential and fluid chemistry The drill hole will be stabilized by an 8 7/8–inch diameter steel pipe that is advanced into the hole behind the drill bit. Drill samples will be collected at one-foot intervals and lithology will be recorded by field personnel. A slurry of sieved cutting material and deionized water will be analyzed in the field on each one-foot of cutting material for specific conductance as a measure of soluble salts. Core material will be collected at selected intervals using a piston core barrel. Core samples will be protected against evaporation and preserved with heat-sealable material using methods described by Hammermeister and others (1986) and Izbicki and others (2000). Natural gamma and neutron logs will be collected from the ODEX drill hole after drilling is completed. The natural gamma log provides a measure of clay abundance and the neutron log provides a measure of the relative water content of the unsaturated deposits.

The borehole will be equipped with a two-inch diameter PVC water table well, three advanced tensiometers, eight heat dissipation probes, and 10 suction cup lysimeters (Figure 3). Depth of instrument placement will be determined from lithologic and chemical data and geophysical logs collected during drilling. The water table well will provide a measuring point for water level and water quality data collection and will serve as an access tube for geophysical instruments. Advanced tensiometers determine matric potential within the tensiomenter range (about -800 cm) and, if saturated, pressure up to about 800 cm. Advanced tensiometers are commonly installed above clay layers or other materials where saturated conditions are expected to develop during recharge. Advanced tensiometers are connected to the surface through a one-inch diameter PVC pipe and only a limited number can be installed in a borehole. The heat dissipation probes measure matric potentials drier than the tensiometer range from -7 cm to -10,000 cm. Heat dissipation probes, which are commonly installed in thick, coarse-grained layers or beneath clay layers, are connected to the surface through wires. The number of heat dissipation probes installed in a borehole is usually limited to the number of available channels on the data logger, usually eight. Suction cup lysimeters extract water from saturated material and unsaturated material having matric potentials less negative than about -60 cm. The wetter the material, the more water will be extracted by the lysimeter The suction cup lysimeters are connected to the surface using two, 1/8-inch diameter tubes, one for vacuum and pressurization of the lysimeter and the other for sample collection.

Each instrument will be installed in a specialized material that is intended to facilitate equilibrium between the instrument and the matric potential of the unsaturated deposits. These materials include #60 graded sand for advanced tensiometers, and silica flour for heat-dissipation probes, dielectric permittivity sensors, and suction-cup lysimeters. The materials have been tested in previous studies and have been shown to not contaminate water samples for selected trace elements such as chromium or arsenic. Additional testing will be done as part of this study to ensure borehole materials do not contaminate unsaturated zone water with arsenic. The borehole will be sealed between instruments using a low-permeability bentonite grout to ensure the borehole will not be a conduit for the downward flow of water Frequent sounding are required to ensure backfill material is properly placed with respect to instruments in the borehole and to ensure the integrity of features, such as low-permeability clay layers that may impede the downward movement of infiltrating water After site completion, an electromagnetic (EM) log will

be collected from the PVC well to insure instruments were properly placed within the borehole. The EM log as will serve as a baseline to evaluate changes in electromagnetic resistivity of unsaturated materials caused by infiltrating water during the experiment.

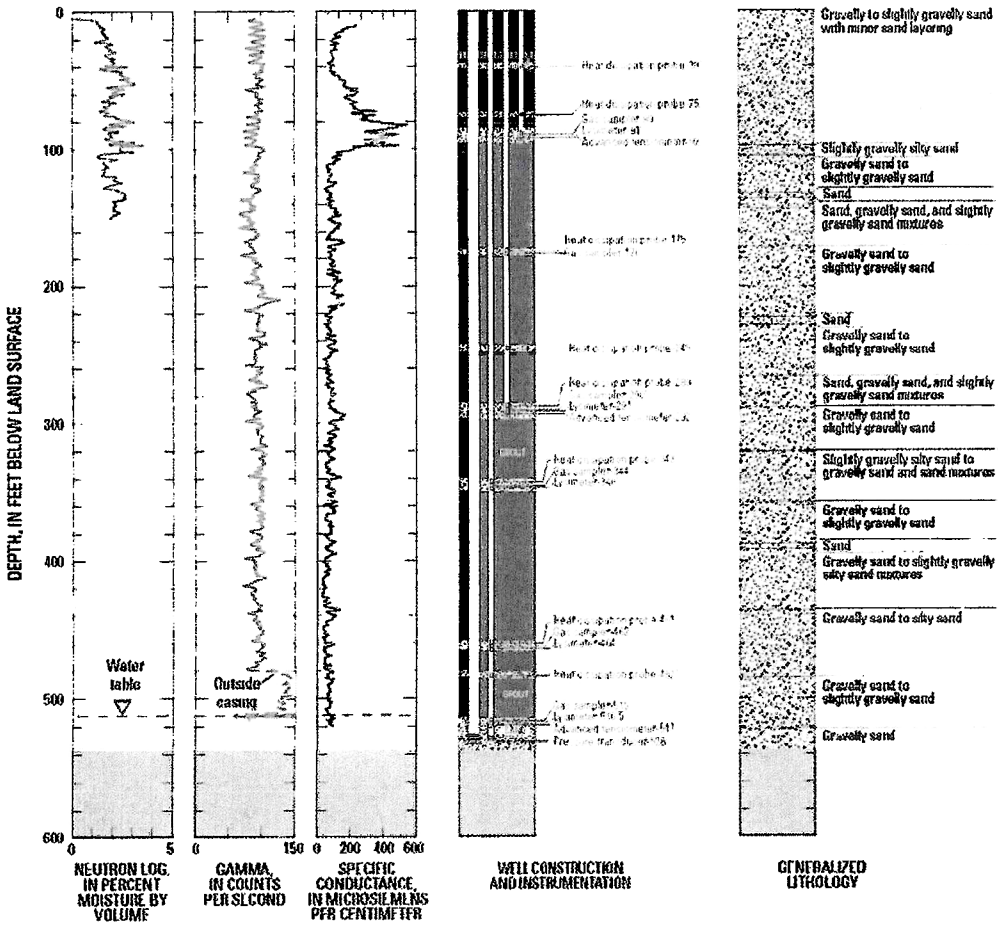


Figure 3.—Design of a typical unsaturated zone monitoring site.

Task 2: Determination of physical and chemical properties of unsaturated materials

Physical and chemical properties of unsaturated material collected during drilling will be measured at USGS laboratories in Sacramento, California (physical properties), San Diego, California (soluble anions), and Denver, Colorado (trace elements). Analysis of material from the borehole will be needed to refine estimates of the performance of the in-situ removal of arsenic.

Physical Properties: Physical properties, such as water content, matric potential, saturated hydraulic conductivity, and unsaturated hydraulic conductivity will be determined using standard ASTM procedures on core material preserved in the field to prevent moisture loss. Water content will be measured gravimentrically on a weight basis. Gravimetric water content will be converted to volumetric water content on the basis of sample bulk density measure on the same material. Matric potential will be measured using the filter paper method. Calibrated filter papers will be inserted into the top and bottom of core liners in the field at the time of collection as part of the preservation process.

Particle-size data can be measured on ODEX drill cuttings and will be determined more frequently than other physical properties. These data provide an opportunity to extend more expensive analytical data from less-frequently collected core material to other depths within the unsaturated zone. In addition to physical properties the organic carbon content of selected samples also will be measured.

Soluble Anions: Water extractions will be done to extract soluble salts from unsaturated material collected from the borehole. Water extractions will be prepared on a one to one, weight per weight basis, with drill cutting and deionized water Extractions will be shaken on a wrist shaker for 24 hours, allowed to stand, or if necessary centrifuged, to allow particulates to settle, and filtered prior to analysis for pH and by ion-chromotography for chloride, nitrate, fluoride, phosphate, and sulfate. Results will be expressed as micrograms per gram of alluvium. Chloride provides a measure of natural recharge through the unsaturated zone or if no recharge is occurring the length of time since recharge last occurred. Soluble anions accumulated in the unsaturated also may alter the quality of infiltrating water as it first passes through the unsaturated zone to the water table.

Trace Elements: Acid extractions will be done using methods described by Chao and Sanzalone (1989) and modified by Izbicki and others (2008b) to extract metals sorbed on mineral grains in the unsaturated zone. Although operationally defined, the extractions are believed to be sufficiently vigorous to remove the oxide coatings on mineral grains without digesting (dissolving) the mineral grains. Extractions will be analyzed for arsenic, chromium, vanadium, uranium, aluminum, iron and manganese using ICP-MS Results will be expressed in micrograms per gram of alluvium. Acid-extract data from different depths will be normalized for the availability of exchange sites on the basis of aluminum, iron, and manganese data. These results will be compared with data normalized for surface area on the basis of concurrent particle-size data.

Acid-extract data will be used to compare arsenic abundance with data from other sites in the Mojave Desert. These data also will be used as a baseline to evaluate the sorption and distribution of arsenic and other trace elements in the unsaturated zone after water has reached the water table. The data also will be used to refine estimates of oxide abundance and sorptive capacity and to determine the projected life of the *in-situ* arsenic removal project.

Toxicity characteristic leaching procedure (TCLP), Method 1311 (U.S. Environmental Protection Agency, 1992), will be done on selected cuttings to determine the amount of arsenic and other selected trace elements that may be mobilized from the material. This test is used to determine if a material qualifies as a hazardous waste. Alumina and iron oxides used in commercially available media to remove arsenic from groundwater have a high surface area, and consequently a high sorptive capacity, per unit weight. When spent these media commonly exceed TCLP values and are considered hazardous. Sorption of arsenic on alumina and iron oxides on mineral grains is unlikely to create a hazardous waste because TCLP values are on a per weight basis and most of the mineral grain is inert silicates.

Task 3: Laboratory Studies of Arsenic Sorption

Column experiments will be done on samples of unsaturated alluvium collected during test drilling to determine sorptive properties of three representative materials selected on the basis of texture and paleosol development. Materials will be obtained during drilling and are expected to range from sandy-textured alluvium, to silty alluvium, to pedogenically-altered alluvium. The

experiments will be done at the U S. Soli Salinity Laboratory in Riverside, Calif. Results of laboratory experiments will be used to interpret field-scale experiment and to develop a methodology to transfer results to other areas.

To obtain sufficient material for the column studies, selected samples from different depths will be aggregated, sieved to remove gravels, and homogenized using a soil splitter For each sample material, column experiments will be done under alkaline, oxic conditions using water that has chemistry similar to water that will be infiltrated at the site. The experiments will be done at two pH's and at two As V concentrations. Experimental water at pH levels between slightly alkaline (7.5) to highly alkaline (8.5) and at As V concentrations between 10 to 100 g/L will be used. Alkaline pH's, exceeding 7.5 and as high as 10, are typical for unsaturated zone water in arid areas. Three replicate columns will be run for each textural type, pH, and arsenic concentration for a total of 36, one-foot long by two-inch diameter, columns. Depending on the permeability of alluvial materials column length may need to be adjusted to ensure adequate contact between infiltrating water and column material. An additional set of three columns will be prepared to evaluate sorption of As III for one textural type, at one pH, and at one As V concentration. Aggregation and homogenization of material from different depths is necessary to obtain a sufficiently large volume of material having uniform properties for analysis.

Prior to the experiment, selected physical and chemical properties of the aggregated and homogenized sample material will be determined including: particle size, surface area, organic carbon content, and extractable metals (iron, manganese, and arsenic) Extractable metal concentrations will be determined using a sequential procedure designed to evaluate operationally defined sorption sites on the alluvium. In addition, TCLP analysis of aggregated material will be done to determine the materials potential for toxicity with respect to arsenic. Hazardous concentrations of arsenic are not expected to be encountered in native material or produced as part of this experiment.

Water having major-ion concentrations similar to native water (Table 1) will be prepared in the laboratory and infiltrated through the columns. Laboratory prepared water will be used rather than native water from the site to avoid unforeseen sorptive, reductive or other interferences in the experiments. Approximately 50 pore-volumes of laboratory water, which will depend on the timing of the arsenic breakthrough from the column, will be passed through the columns. Flow through the columns will be continuous and discrete pore-volumes will be analyzed for pH, specific conductance, and arsenic concentrations to characterize the arsenic breakthrough from the column and to determine the sorptive capacity of the material. After the experiment, material in the column will be harvested and analyzed for sequentially extractable metals and TCLP to determine where in the column, and within which operational fraction defined by the sequential extraction procedure, the arsenic has sorbed. Results of the experiment will be interpreted using the computer program UnsatChem to develop predictive relations between the measured physical and chemical characteristics of the alluvium and arsenic sorption

A series of desorption experiments will be done to determine the mobility of As V sorbed on the experimental columns at different pH's and water compositions. The experiments will be designed in consultation with the RWQCB to meet regulatory needs and will be done shortly after the completion of the initial sorption experiment using water having a low-arsenic concentration but otherwise similar in composition to the experimental water used in the column studies. Additional desorption experiments may be required using water having a range of pH and dissolved organic carbon concentrations to determine the long-term mobility or immobility of arsenic sorbed on alluvial deposits. These additional experiments are beyond the scope of this proposal. The primary concern is whether or not sorbed arsenic will become mobile under

changing hydrologic conditions in the future or will the arsenic become increasingly mineralized and less mobile with time. It is not possible to address changes in arsenic mobility resulting from incorporation of sorbed arsenic into mineral phases through time using the traditional column experiments described previously

To address this issue, batch experiments will be done on homogenized sample material slurried with sample water amended with arsenic-73 at known concentrations. Arsenic-73 is a radioactive isotope of arsenic having a half life of approximately 80 days. Initial arsenic-73 activities in the batch experiments will be sufficiently large to ensure measurable radiation in the slurries for as long as one year The slurries will be incubated under oxic conditions typical of unsaturated zones and at temperatures and pH's expected in the unsaturated zone. Material from the batch experiments will be harvested at selected intervals and samples analyzed to determine if the arsenic concentrations on operationally defined sorption sites change with time. Arsenic-73 is used for this purpose rather than tradition chemical measurements because small changes in arsenic-73 partitioning within the solid phase can be easily and directly measured on the basis of radioactivity These data will be used to determine if the sorbed arsenic has become increasingly mineralized and therefore less mobile with time, or if arsenic remains sorbed on minerals grains and highly mobile given changing geochemical conditions in the unsaturated zone Batch experiments are more suitable for this type of experiment than column experiments because of the smaller volumes of water requiring less radioactive arsenic-73 needed for the experiment. Results of these studies will be used to determine if land use controls may be needed to prevent future mobilization of arsenic beneath recharge ponds.

Task 4. Data collection from the Instrumented Borehole

Monitoring of the infiltration and movement of applied high-arsenic water through the unsaturated zone will be done using a combination of data collected from the instrumented borehole installed in Task 1 Data collection at the site will begin prior to the onset of infiltration from the pond, during infiltration from the pond, and continue until infiltrated water reaches the water table. The pond will be about one acre in size with an assumed pond depth of about two feet. The infiltration rate is expected to be about two feet per day with a residence time in the pond of about one day The chemistry of source water to the pond and water within the pond will be monitored during this study for constituents listed in Table 2. Expected composition of the source water is given in Table 1 Although almost all the sorption of arsenic is expected to occur in the unsaturated zone, algae grown within the pond will be sampled to determine if it accumulates arsenic.

Initially, water is expected to take about two years to reach the water table 300 feet below land surface. The downward rate of water movement is a function the hydraulic properties of the unsaturated material and the volume of water infiltrated from the pond. The more water applied and infiltrated from the pond, the more rapidly the unsaturated zone beneath the pond will be wetted. Once the unsaturated zone has been wetted by infiltrating water, the downward rate of movement of infiltrating water will increase, possibly reaching the water table in about one year

Data from advanced tensiometers and heat dissipation probes will be collected at four-hour intervals from the surface using data loggers installed in a vault at land surface shortly after completion of the borehole. The data logger can be operated either on batteries, batteries supplemented with solar power, or, preferably from power at the site. Equilibration of instruments and surrounding backfill will be monitored to ensure instrument performance, determine when the borehole has equilibrated with the surrounding unsaturated zone, and provide background data prior to the infiltration of water at the site.

After the backfill has equilibrated with the unsaturated zone and grout has hydrated an EM log will be collected. This log will serve as a baseline to evaluate changes in water content in the unsaturated zone between instruments after water has been infiltrated from the pond. After water is applied to the pond, EM logs will be collected about every other month to monitor the downward migration of the applied water

Samples will be collected from the lysimeters at six-week intervals when the lysimeters are serviced. Initial matric potentials are expected to be more negative than -60 cm and lysimeters are not expected to produce water prior to the infiltration of water Water from the lysimeters will be analyzed for field parameters (pH and specific conductance only), selected anions (including chloride, nitrate, and sulfate), selected trace elements (including arsenic, chromium, vanadium, and uranium), and the stable isotopes of oxygen and hydrogen (Table 2). Frequently, lysimeters do not produce sufficient water for all constituents to be analyzed. Assuming sufficient volume for analysis, two samples from the lysimeters, which will ideally be collected shortly after the lysimeter begins to produce water and near the end of the study, will be analyzed for the more complete suite of constituents measured from the well.

The water table well installed at the site will be sampled prior to the application of water to the pond and after the applied water has reached the water table. Water from the well will be analyzed for field parameters (pH, specific conductance, temperature, and dissolved oxygen) major ions, nutrients, selected trace elements (including arsenic, chromium, vanadium, and uranium) and the stable isotopes of oxygen and hydrogen (Table 2). The redox species of arsenic and chromium will also be determined. In addition to the water table well, nearby agricultural supply wells will be sampled and analyzed as part of this study (Figure 2). The analyses of water from the monitoring well and selected nearby production wells are needed to evaluate expected water chemistry changes in the upper aquifer prior to the infiltration of water from the proposed test pond to the shallow aquifer

Table 2.—Major-ion, selected trace-element, and nutrient data to be analyzed as part of this study

[USGS parameter code assigned for identification and data storage purposes in USGS National Water Information System (NWIS). CAS number. Chemical Abstract Services number assigned by the American Chemical Society for identification and computer search purposes. --, CAS number not assigned. Laboratory reporting level (LRL) is in milligrams per liter (mg/L), micrograms per liter (µg/L), microSiemens per centimeter (µS/cm), or standard units for pH. Lower values may be reported as estimated concentrations if compound is present. For surrogates and spikes the LRL is in percent (pct.).]

| Compound | USGS parameter code | CAS number | Laboratory reporting level | |
|---|---|---|---|---|
| **Major-ions and selected trace elements** | | | | |
| Alkalinity, laboratory | 29801 | 471-34-1 | 8 | mg/L |
| Aluminum | 01106 | 7429-90-5 | 4 | µg/L |
| Arsenic [total dissolved As (V) + As (III)] | 01000 | 7440-38-2 | 0 06 | µg/L |
| Arsenic (V) | 62453 | 15584-04-0 | 0.8 | µg/L |
| Arsenic (III) | 62452 | 15502-74-06 | 0.8 | µg/L |
| Barium | 01005 | 7440-39-3 | 0.6 | µg/L |
| Boron | 01020 | 7440-42-8 | 2 | µg/L |

| | | | | |
|---|---|---|---|---|
| Bromide | 71870 | 24959-67-9 | 0.02 | mg/L |
| Calcium | 00915 | 7440-70-2 | 0.02 | mg/L |
| Chloride | 00940 | 16887-00-6 | 0.12 | mg/L |
| Chromium | 01030 | 7440-47-3 | 0.12 | µg/L |
| Fluoride | 00950 | 16984-48-8 | 0.08 | mg/L |
| Iodide | 71865 | 7553-56-2 | 0.002 | mg/L |
| Iron | 01046 | 7439-89-6 | 4 | µg/L |
| Lithium | 01130 | 7439-93-2 | 0.06 | µg/L |
| Magnesium | 00925 | 7439-95-4 | 0.012 | mg/L |
| Manganese | 01056 | 7439-96-5 | 0.2 | µg/L |
| pH, laboratory | 00403 | -- | 0.1 | pH |
| Potassium | 00935 | 7440-09-7 | 0.06 | mg/L |
| Residue, 180 degrees Celsius (Total Dissolved Solids) | 70300 | -- | 10 | mg/L |
| Silica | 00955 | 7631-86-9 | 0.20 | mg/L |
| Sodium | 00930 | 7440-23-5 | 0.12 | mg/L |
| Specific conductance, laboratory | 90095 | -- | 5 | µS/cm |
| Strontium | 01080 | 7440-24-6 | 0.4 | µg/L |
| Sulfate | 00945 | 14808-79-8 | 0.18 | mg/L |
| Vanadium | 01085 | 7440-62-2 | 0.16 | µg/L |
| Uranium | 22703 | 7440-61-1 | 0.006 | µg/L |
| **Nutrients** | | | | |
| Nitrogen, ammonia as N | 00608 | 7664-41-7 | 0.02 | mg/L |
| Nitrogen, ammonia + organic nitrogen | 00623 | 17778-88-0 | 0.1 | mg/L |
| Nitrogen, nitrite | 00613 | 14797-65-0 | 0.002 | mg/L |
| Nitrogen, nitrite + nitrate | 00631 | | 0.04 | mg/L |
| Phosphorus | 00666 | 7723-14-0 | 0.04 | mg/L |
| Phosphorus, phosphate, ortho | 00671 | 14265-44-2 | 0.008 | mg/L |

Methods from Fishman and Friedman, 1989; Fishman, 1993; Garbino and others, 2002 and 2006.

## Task 5. Evaluation of Experimental Performance

The performance of the pond and the underlying unsaturated material to sorb arsenic will be evaluated on an ongoing basis during the study The breakthrough of arsenic in lysimeters at different depths will be compared to expected breakthrough estimated on the basis of alumina, iron, and manganese oxides measured in drill cuttings collected from the unsaturated zone and on the results of laboratory column experiments. If arsenic is mobile and the sorption of arsenic differs unfavorably from expected sorption and removal of arsenic demonstrated in laboratory studies, the experiment can be stopped at any time and the approach reevaluated. The stopping point is mentioned below in the mitigation plan.

### Quality Assurance / Quality Control

Field Methods: All field sampling techniques will follow protocols described in the "National Field Manual for the Collection of Water Quality Data", Chapters 1-9, F.D. Wilde and others, editors, U.S, Department of the Interior, U.S. Geological Survey, 1997-2007 In addition, all USGS California District field personnel have ongoing personal QA/QC training and testing to ensure that all water quality data is collected according to the best possible protocols. Instruments installed in boreholes are calibrated using procedures described by Flint and others (2002). Matric potential data and water-level data will be collected at four-hour intervals. The water level data from pressure transducers will be confirmed with measurements made at six-week intervals during routine service at the site.

Field Blanks, Equipment Blanks, and Duplicates: The project will follow protocols established by the National Assessment of Water Quality (NAWQA) Program for the collection of blanks and duplicate samples. In general, for trips to the field in which fewer than ten water quality samples are taken, one each of Field Blank, Equipment Blank, and a Duplicate Sample will be taken and analyzed along with the water quality samples. For trips to the field in which greater than ten water quality samples are taken, one each of Field Blank, Equipment Blank, and a Duplicate Sample per ten water quality samples will be taken and analyzed along with the water quality samples.

Analytical QA/QC: All samples will be sent to the USGS National Water Quality Laboratory (NWQL) for analysis. Details of the NWQL QA/QC protocols can be seen in the two attached appendices: Appendix 2: Quality Control at the U S. Geological Survey National Water Quality laboratory, Fact Sheet FS-026-98 (Pirkey and Glodt, 1998); and Appendix 3: Participation in Performance Evaluation Studies by U.S. Geological Survey National Water Quality Laboratory, Fact Sheet FS-023-98 (Glodt and Pirkey, 1998).

**Mitigation Plan**

As part of the experimental design we will 1) monitor at shallow depths to ensure that arsenic is being rapidly removed as planned, and 2) monitor at the water table to ensure water actually recharged is low in arsenic. If arsenic removal does not occur as planned, we will know long before the water reaches the water table. In the worst case scenario, if there is no arsenic removal, we will be able to stop the experiment before the water infiltrates to more than 100 feet below land surface(bls) Background arsenic concentrations range from 29 ppb to 4 ppb. We chose the lowest concentration of 4 ppb as the threshold concentration at 100 feet bls where pumping will stop if that concentration is exceeded. Groundwater modeling was done using TOUGH2 for a scenario where pumping is stopped if the threshold concentration is exceeded at 100 feet bls. The model was done assuming the same lithology as nearby AVEK agricultural well RG-3 and an infiltration rate of 0.55 acre-feet per day A one-acre circular pond was used and after 3 months, infiltration was stopped where the wetting front reached 100 feet. After 4 months, the infiltrated water perched on a clay layer and would not infiltrate vertically any further Modeling results show that the small amount of water recharged at this decision milestone (4 months) would not infiltrate to the water table during the 180 month (15 year) simulation period. In the absolute worst case scenario only 66 acre-feet of water would be infiltrated. If that small amount of water ever reached the water table, dilution with native water or dilution with water infiltrated water elsewhere on the property (anticipated to be about 30,000 ac-ft per year) would render the increase in arsenic concentrations associated with the experiment at the water-table beneath the site insignificant (and immeasurable)